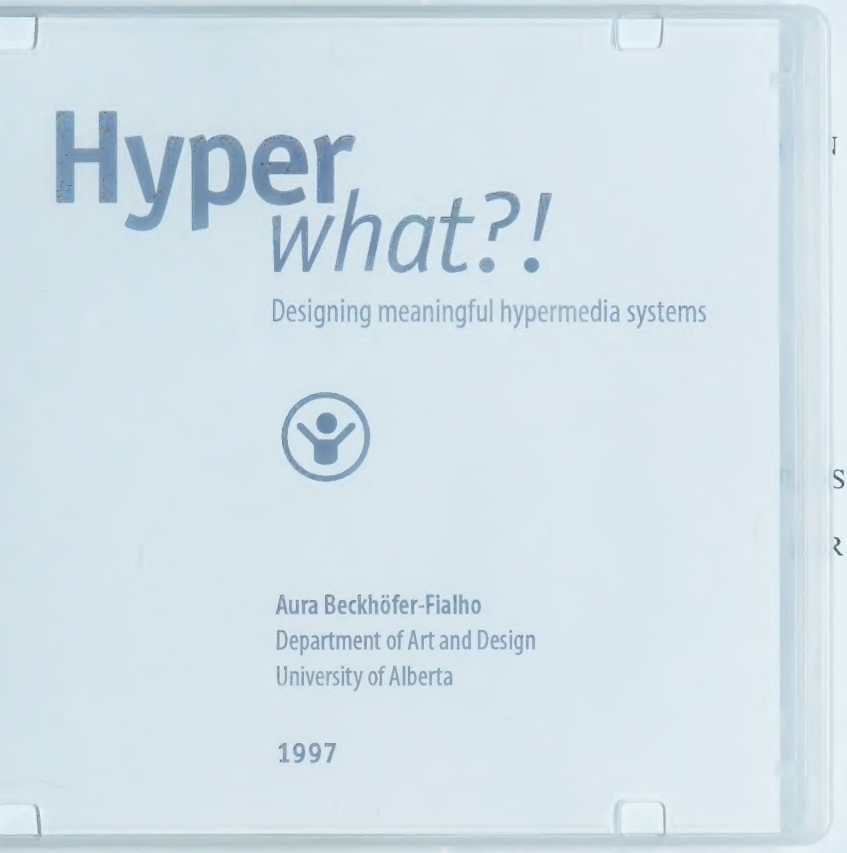

S AND RESEARCH

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EDMONTON, ALBERTA

FALL 1997

THE UNIVERSITY OF ALBERTA

MDES FINAL VISUAL PRESENTATION

by

AURA BECKHOFER-FIALHO

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Hyper*what?!*

Designing meaningful hypermedia systems

Master of Design thesis
in Visual Communication Design

print version

Aura Beckhöfer-Fialho
Department of Art and Design
University of Alberta

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Introduction

This thesis makes an attempt at exploring the human aspect of a new information technology. I believe that there is a need, now more than ever, to put technology in perspective and to give people back the control which they (or rather we) perceive to have lost on our path towards technological nirvana. The information technology which will be the focus of this thesis is hypermedia, mainly because it is the technology which we believe to have the most influence on how communication and information dissemination will evolve in our society. It is also one of the most misunderstood and thus worthy of critical investigation.

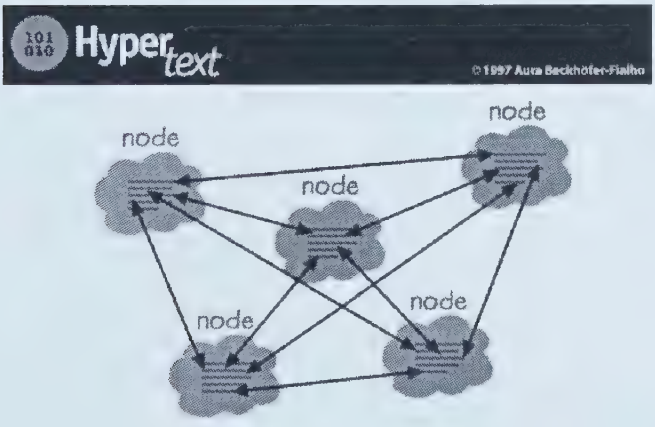
The new information technology of hypermedia, which supports such networks as the World Wide Web, is being hailed as the latest cognitive revolutionary invention of humankind. (Harnad, 1991) The first cognitive revolution came with the development of language which enabled us to communicate our thoughts to one another. With writing, we gave our thoughts a material existence and permanence. Then came print which allowed us to overcome both time and space and made possible the dissemination of information on a scale never before accomplished. And now we have hypermedia. The permanence is gone and yet the information "lives on", transcending the material, but never quite freeing itself from the medium. As a result, we communicate faster. But do we communicate better? Does the fact that we *can* necessarily mean that we *must?*

As designers, it is crucial that we understand the issues pertaining to the adoption of hypermedia-supported systems in a human communication context since it will have an effect on how we project the exchange of information to take place for some time to come. As people, it is important for us to recognize that consciously, or at times as an unconscious collective, we can determine the role which technology plays in our society. And while new information technologies such as hypermedia open up new possibilities in the realm of human communication (and information dissemination), what we choose to do with it is primarily in the hands of people, whether we want the burden of that responsibility or not. In short, to declare that hypermedia will forever change the way we deal with information is false. It is not hypermedia alone which will create change, but more importantly who is developing, using, and promoting it.

Defining a new technology inevitably comes down to language: most of us do not agree on the words which we commonly use to define new communication technologies which, to complicate matters further, are representative of abstract concepts rather than real things. We speak of multimedia, hypermedia, hypertext and the Internet with a sense of mysticism and reverence which defies our understanding. Words like media are used interchangeably with technology, while information is often confused with data. As a result, most of us do not understand how the new technology works and feel unprepared to make decisions on how it should be used, if indeed it should be used at all. By employing vague terminology, we hint at the fact that none of us really wants to take responsibility for the way things are and where they might possibly be heading. By using terms such as technology and media, we neatly remove the human element, thus giving the inventions which we have created a life and momentum of their own over which we appear to have no control. The first of many steps towards remedying this situation involves clarifying what it is that we are all talking – and often *mis*communicating – about.

1.1 hypertext

In order to better understand the technology of hypermedia, it is important to grasp the basic concepts of hypertext. In its simplest form, a hypertext system can be represented as a network of nodes (each symbolizing a text document) whose relationships are represented by links. In essence, hypertext is an interactive, multilinear information technology which allows the interlinking of various text documents within an open or closed computer-supported networks.



1.1.1 interactivity

At the root of hypertext technology lies its interactive nature. The participant has a direct effect on the way the information is accessed and presented. A person can reorganise it, modify its appearance, change its scope, and the system will respond accordingly. While interactivity is usually meant to represent the interaction which takes place between the person and the information structure,

I believe that the most important and significant aspect of hypertext interactivity lies in the opportunity for people to communicate more freely with one another. When going back to print technology, author and reader rarely, if ever, had the occasion to meet and discuss the ideas and concepts that the author had put forth. Often, there were vast gaps of time and space which separated the two. Taking it one step further, assuming that the exchange had in fact taken place, the written work remained unchanged, at least until the next edition. In a hypertext environment, exchanging ideas, discussing them, and even changing the original body of information becomes an achievable goal. Direct interaction between the author and the reader changes the once unidirectional communication setting into a two-way, interactive environment.

This brings us to another point: the ease with which author and reader can communicate, create new form from the precedent necessarily leads to a breakdown of the traditional roles that each have played in the original form of interaction. The reader becomes author, the author becomes collaborator, and in turn becomes the reader. The divisions are blurred, creating a new environment for exchange that is free of hierarchy and potentially indicates the end of the great canons of literature around which our educational systems have depended on to sort the important from the insignificant; a form of censorship which has inevitably favoured one social group over another, one culture over another, one sex over another. As George Landow points out:

> **All authors on hypertext who touch upon the political implications of hypertext assume that the technology is essentially democratizing and that it therefore supports some sort of decentralized, liberated existence. (1992)**

With a lack of hierarchy, however, comes a necessary loss of credibility. When every document is considered equal, it becomes difficult to distinguish that which is useful, true, significant, from that which is not. Åm notes:

> **An environment where everything is equally probable is irreducible by knowledge. (1994)**

1.1.2 multilinearity

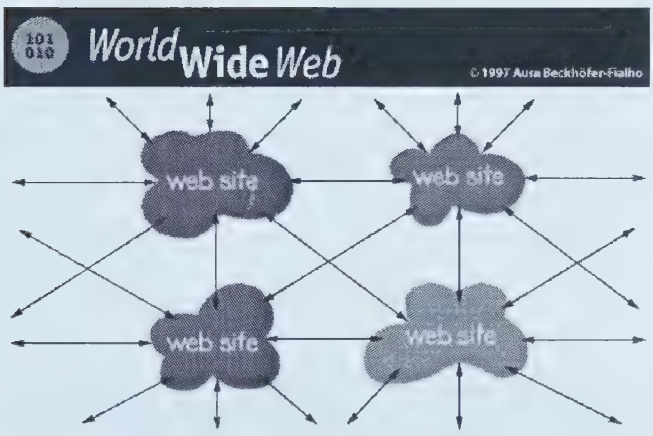
Hypertext technology supports multilinearity in that in a hypertext environment, there is no set beginning or end, nor a preferred sequence of accessing the information over any other. Most books, on the other hand, are linear in

nature and suggest a path for the reader to follow in order to understand what the author is communicating.

In addition, hypertext cannot exist without computers. Since the information is digital and access to it is not bound to a unique physical space, hypertext technology lends itself well to information systems which require numerous people to access simultaneously a shared document regardless of geographic or time constraints.

1.1.3 open & closed systems

Hypertext is often associated with open systems which can be changed at will, added to and reorganized. The World Wide Web is an example of an open hypertext system. By its lack of closure, it is ever-changing. Web sites can be constantly reworked, updated, changed and even removed without compromising the integral structure of the whole.

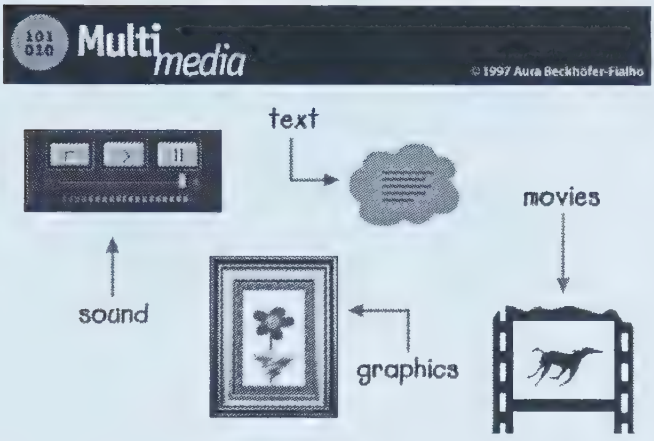


There are also closed hypertext systems, the most familiar being the interactive multimedia CD-ROM which uses hypertext technology, but does not allow ex- pansion since it is fixed within its storage device (the disk). In my opinion, these do not represent true hypertext environments in that the interactivity is restricted to take place between the person and the information only. Interactive CD-ROMs are in fact much closer to the concept of electronic books where the participant is restricted to certain paths which can be followed only because they have been programmed into the system. Thus, a sequence is imposed from the "first page" onwards. Referring to the difference between closed and open systems, Keeley notes:

> **The mistake commonly made with hypermedia is to confuse a train travelling on tracks with a dune buggy crossing the desert. (1990)**

There is no opportunity in a closed system to expand the body of information, nor to reorganize it beyond the realm of customizing the presentation

of its contents such as choosing a typeface for displaying the information or following one of many predetermined paths.

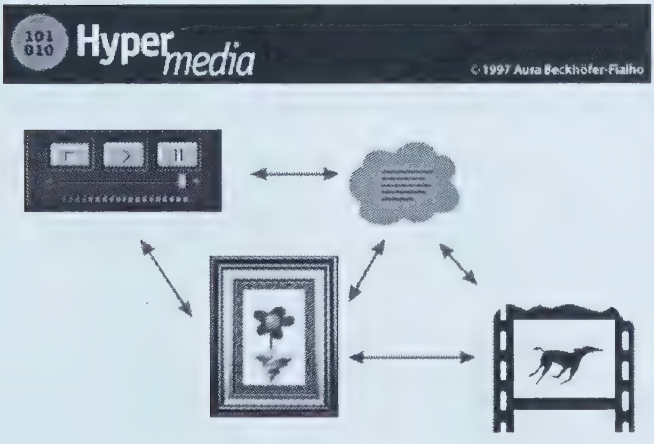


1.2 multimedia

Multimedia is a term that has become increasingly difficult to define since, not unlike the term "design", it has been employed in various instances where its intended meaning is often blurred by the context in which it is used. Multimedia, in essence, is the union of dif-ferent types of data such as text, graphics, sound and movies. Multimedia is a descriptive term, whereas hypertext is a technology.

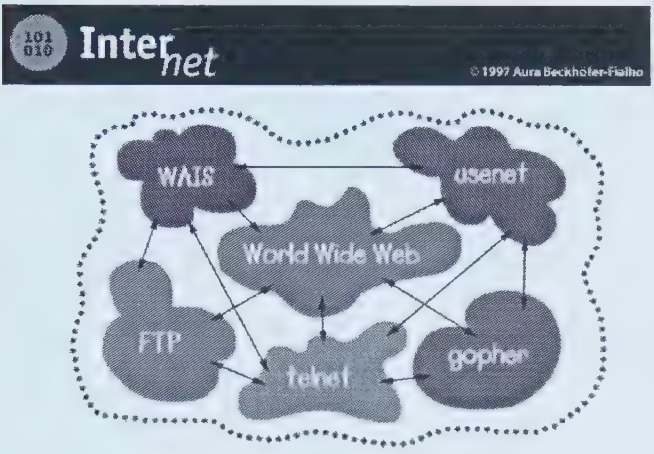
1.3 hypermedia

Hypermedia can be considered the union of hypertext and multimedia. It is a multimedia version of hypertext, allowing not only the interlinking of text documents, but of a wide range of media. Thus, in a hypermedia environment, the definition of a node expands from being a single text document to representing a unique and discrete concept. No longer restricted to text, a person can, in a hypermedia system, link from an image to a film clip, to a sound file, and so on.



1.3.1 modularity

A significant characteristic of a hypermedia system is the modularity of its parts. Just as within the Internet we find the World Wide Web, within the Web, we find yet smaller hypermedia systems called Web sites. The important point remains that any part, however small it may be, is created independent of its counterparts in order for the hypermedia system to be sustainable. Unlike chapters in a novel that direct a person to

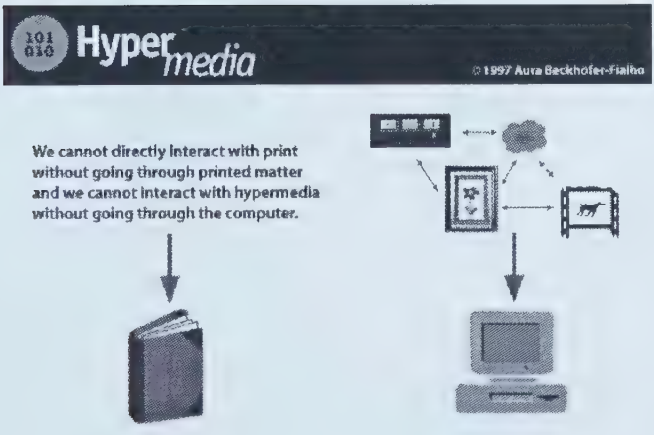


read the previous one before proceeding to the next, hypermedia nodes are created independent of each other since there is no suggested sequence of access to the information.

While modularity is an asset from a system's maintenance perspective, the resulting fragmentation of content often poses cognitive strains on the person using the system.

1.3.2 medium or technology?

Throughout this thesis I refer to hypermedia as a technology rather than, as the name implies, a medium. I justify this classification by stating my belief that hypermedia is to the computer what print is to the book. In other words, hypermedia, like print, is the technology made accessible through the delivery medium: in this case the computer, which is itself a technology-supported device. We cannot interact directly with print without going through printed material (such as books and magazines) and we cannot interact with hypermedia without going through the computer. Thus, in this context, the medium is the tool dimension of the technology. While the book enables us to interact with the technology of print, the computer enables us to interact with the technology of hypermedia.



1.3.3 hypermedia predecessors

There is nothing particularly innovative about the concepts underlying hypertext and hypermedia. In fact, there are several print-based hypertext systems with which we are all familiar today, the encyclopedia being one of many examples. Like the World Wide Web, an encyclopedia is composed of several independent components (in this case volumes) which cross-reference each other (just as Web sites

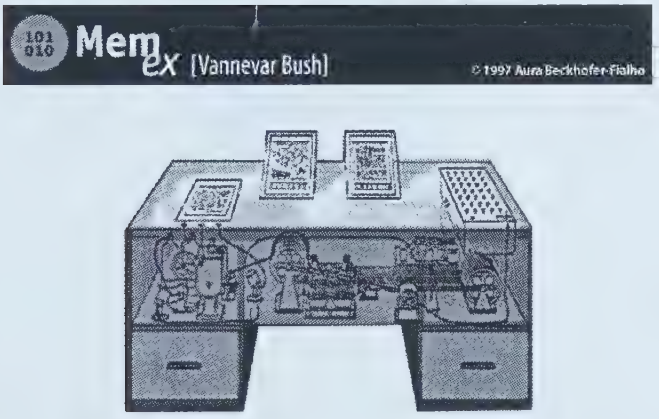
link to one another). Even the European Polyglot Bibles of the Middle Ages were arguably early hypertext systems which consisted of several texts brought together and semantically linked within a manuscript. Thus, on a single page, readers had simultaneous access to the same Biblical passages written in Latin, Greek or Aramaic.

Perhaps a more interactive, albeit sequential, example of a print-based hypertext system can be found in contemporary juvenile adventure novels. In these, the reader comes to a point in the narrative where they are faced with different courses of action and must choose one of many possible paths in order to proceed in the story.

1.3.3.1 bush's memex

The origins of computer-based hypermedia can be roughly traced back to 1945 when Vannevar Bush declared:

> **The summation of human experience is being expanded at a prodigious rate, and the means we use for threading through the consequent maze to the momentarily important item is the same as was used in the days of square-rigged ships. (1945)**



To meet the demanding need of people for efficient information organization and retrieval, Bush devised a desk-like machine with viewing screens, buttons and a keyboard which he called the Memex. This machine was originally intended to store vast amounts of information which could be cross-referenced and reorganized at will. It could contain not only text documents such as books and newspapers, but also photographs, hand- written notes and drawings, all of which were to be stored on microfilm. (Myers & Burton, 1994)

The Memex was never built due to technical constraints, but the concept was picked up on and developed in the 1960's by Ted Nelson who was the first to coin the term hypertext.

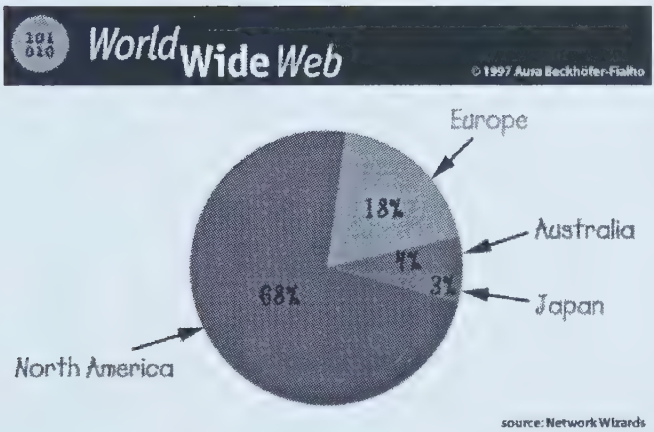
1.3.3.2 nelson's xanadu

Ted Nelson defined hypertext as:

> **A body of written or pictorial material interconnected in a complex way that it could not be conveniently represented on paper. (1965)**

Nelson undertook in the mid 60s an ambitious project which he called "Xanadu," the aim of which was to link on-line all the knowledge in the world and to make it available to anyone who wished to access it – and add to it – providing search indexes which would assist people in obtaining information based on ideas, rather than keywords. (Megarry, 1988) To Nelson, Xanadu embodied his concept of the "docuverse" (document universe), a large hypertext system in which:

> **any user should be able to follow origins and links of material across boundaries of documents, servers, networks, and individual implementations. There should be a unified environment available to everyone providing access to this whole space. (Nelson, 1987)**

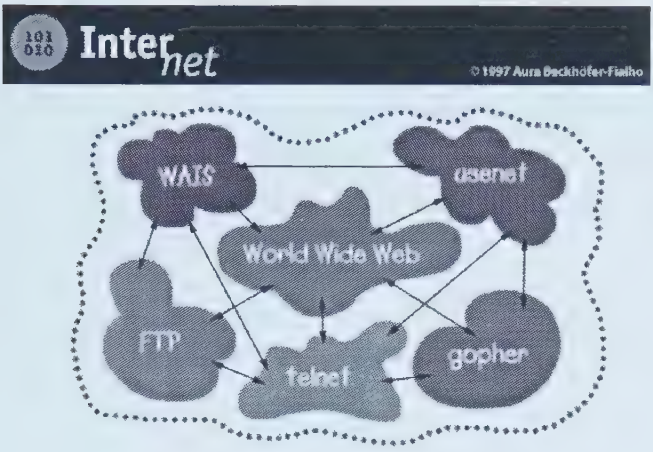


1.4 the world wide web

In principle, the ideal of creating a global hypermedia-supported network of freely-accessible information appears to be underway with the World Wide Web. The main problem with this approach is that it is both economically and culturally biased, since the fascination with the World Wide Web is primarily a North American phenomenon.

1.4.1 the internet

With the introduction of the World Wide Web to the general public in 1992, it has become increasingly difficult to distinguish it from the Internet. The difference lies not in the technology which supports both, but rather in scale and hierarchy. The Internet can be considered as the largest hypermedia system in which we exchange information with one another. It is comprised of several computer networks which are all interconnected and contain in themselves thousands of smaller networks. Before the World Wide Web, however, the Internet was exclusively text-based. In essence, it was a



hypertext environment which could not support multimedia content.

The World Wide Web was in turn introduced as an attempt to create a graphical,"non-threatening" information environment to facilitate communication between people and provide an alternative to the hypertext environment of the Internet.

1.4.2 information overload

A fundamental problem with the approach of indiscriminately interlinking documents is that there is a fine line between having unlimited access to information and overloading on it. As Umberto Eco put it:

> **A bibliography of 20 titles is useful... But what do we do with one of 10,000 titles obtained by pushing a computer button? Into the wastebasket! (Eco, 1991, in Kessler)**

Since its introduction, much of the World Wide Web's information has been data rather than meaningful information."Bits of easily digestible info-nuggets", according to Keeley (1990). The human communication imperative appears, at least for the moment, to have taken a back seat to its own delivery medium. This phenomenon can be explained in part by realizing that we are presently in a transitional stage where new information technologies such as hypermedia and new media such as computers are clashing with older technologies, primarily print and books. As a result, there is often a sense of fear of losing that with which we are familiar. A fear of the new, and an uncertainty as to what to do with it.

We have had hundreds of years to get accustomed to, and refine, the information technology of print. On the other hand, hypermedia as a new information technology is a recent occurrence in the development of human communication technologies, and one for which we must define a role before it can become truly useful and integrated. As a result of its novelty, the World Wide Web is not so much a communication environment at this point in time, as it is a seemingly endless repository of data through which we must wade in order to find content and meaningful interaction with other people.

> **We have to believe in free will. We've got no choice. (I. B. Singer)**

We clearly attribute a value to technologies which transcends their usefulness as tools. The automobile, for instance, is far more than simply a means to get from point A to point B. As Maddux notes,

> **The automobile and the computer are means that have become, at least to some extent, ends in themselves. (1994)**

By determining to what extent we perceive technology to create social change, we can begin to understand why technology is so important to us and how in turn we can use that knowledge to regain control over it: a control which we often perceive to have lost.

As a technocentric stance, technological determinism is a theory which places technology at the forefront of any changes which occur in society. Pushing the view further, technological determinists believe that the very nature of a culture and society is determined primarily by its technology, and more precisely, its information and communication technology. Thus, following this view, a change in information technologies necessarily leads to fundamental changes in society. (Chandler, 1995)

It is interesting to note that the technological determinist has historically been in the majority: it appears that the technological stance is one often taken for granted and accepted as common sense.

2.1 reductionism

At the heart of technological determinism lies the concept of reductionism. Reductionism is a scientific approach to understanding the complex, it is also a natural one. Reductionism involves simplifying issues to the point of attributing a single cause to any event, to oversimplify in order to gain understanding, to break down a complex matter into small, easily assimilated and analyzable components. There is no place in the reductionist stance for unanticipated events, or emotions for that matter. For example, reducing all of human behaviour to a series of predetermined "human factors" is one of many examples of reductionism which are readily accepted and perpetuated in society. Another example involves attributing societal change to the development of a specific technology. (Chandler, 1995)

In essence, much of Marshall McLuhan's work revolves around the reductionist stance whereby culture and society are determined by the technologies they develop and embrace. When we speak of hypermedia revolutionizing human communication and information exchange, we are making a reductionist statement by ignoring the social, cultural and economic forces which come into play.

2.2 reification

Contributing to our glorification of new information technologies and their perceived role in changing the very heart of our culture is the notion of reification. To reify means to treat a concept, an abstract notion as an entity. We are all, to a certain degree, guilty of reification when speaking of technological issues. As Daniel Chandler explains it, to reify technology "involves treating it as if it were a single material thing with a homogeneous, undifferentiated character." (1995) This stance is further reinforced by our constant need to label, categorize and analyse. In fact, this thesis relies heavily on reification since it deals with *People, Technology* and *Hypermedia.*

2.3 technological autonomy

> **There can be no human autonomy in the face of technical autonomy. (Ellul, 1964)**

The idea of technological autonomy is based on the concept of reification. Rather than being perceived as a human creation and an intricate part of our culture, when we speak of technology, we speak of something which seems quite separate and independent of us with a will and motivation of its own... And much to our dismay, often out of our control. The ghost in the machine rears its head and we are at a loss as to how to exorcise it.

A probable outcome of the belief in technological autonomy results in many people, already intimidated by new technology, to abstain from partaking in the shaping of its uses in society because of its implied "mysticism". This further explains why so many people want to have a "presence" on the World Wide Web, without really understanding why or what they will do with it once they get it. Commenting on this increasingly disturbing attitude, Chandler adds sarcastically:

> **Our role as responsible forward-looking citizens is to accept, adjust and adapt without protest to the new technology as a fact of life. (1995)**

2.4 the technological imperative

> **Once a new technology rolls over you, if you are not part of the steam roller, you're part of the road. (Brand, 1988)**

Often, the idea of technological autonomy breeds an anthropomorphic view which emerges from the notion that the whole is greater than the sum of its human-created parts. It is but a very short conceptual jump from technological autonomy to the technological imperative, which separates the human creator from the invention. Technological developments become intricately linked with our notion of progress, and progress, once under way, is often perceived as being unstoppable:

> **In our contemporary visual language the influence of the computer is inescapable. (MacKenzie, 1994)**

Simply put, the technological imperative states that if a technology permits us to do something, then we are not only ethically, but morally bound to do it. The zeal with which people are getting involved with hypermedia systems is an example of the technological imperative at work: we *can*, therefore we *must*. The issue is further complicated by our perception of increased dependency on technological developments. The more we rely on technology, the more difficult it becomes to relinquish it. The greater the technological substructure, the more impossible it seems to live without it. We often do not realize that there was no need manifested until the means to satisfy it were created and someone could economically and politically profit from it.

Typical of the technological imperative is the approach to pursuing technological developments for their own sake since technological progress inevitably leads to cultural and social progress. This does not mean, however, that all technological pursuits are created equal. That would be indeed reductionist for we have to keep in mind that economical factors are often at work when the notion of progress is developed.

2.5 technological neutrality

To concede that there is no such thing as a technological imperative does not necessarily point toward technological neutrality. As Neil Postman noted, "to a man with a hammer, all the world looks like a nail..." (1993) meaning that there is cultural symbolism associated with technologies, as well as underlying biases which are not always obvious at first glance. Although we are not

at the mercy of our technologies, we are nevertheless influenced by our choices. Furthermore, certain technologies may be more compatible with certain areas of society than others, and can in turn be used by some people to gain political and economical advantage over other people.

> **The use-intimidating complexity of computer language... Facilitates the monopolization of valuable knowledge in the interest of elite power. (di Norcia, 1986)**

2.6 socio-cultural determinism

At the other end of the spectrum, we have voluntarism which is a humanistic, socio-cultural deterministic stance. For every technological determinist stating that technology shapes society, there is a voluntarist declaring that people are free agents with a will of their own and complete control over the technologies which they have created.

The problem with any extremist stance is obvious: by oversimplifying the issue, there is no space left to consider the unpredictable, the chance occurrence and the unexpected. As Chandler put it:

> **Results are what you expect, consequences are what you get. (1995)**

2.7 hard & soft technological determinism

> **Technological determinism generally varies in degrees of technological emphasis. Thus, there is hard technological determinism which accounts for societal changes in terms of technology alone, and soft technological determinism which allows for the possibility of human intervention, while still attributing most of the impact to technology. (Finnegan, 1988)**

Most people today believe in some form of technological determinism, ranging from mild to excessive, in accordance with the introduction of new technological advances such as hypermedia in a human communication context. Unless we take a step back and contemplate objectively how we view the role of technology in our society, we may never realize that:

> **Communication is something that goes on between people whether mediated through technology or face-to-face.; it is the process by which we generate meaning and make sense of the world. Whether we do so cleverly or stupidly is dependent on a complex of factors that have little to do with technology per se... You cannot use technology to pump meaning and sense into human beings. (Sless, 1994)**

Finally, technological determinism often leads to a belief that technologies define historical periods, examples of which abound when we refer to such eras as the space age, the electronic age and the information age. (Chandler, 1995) Such an outlook eventually leads to the belief that with every new technology which is introduced, another dies out. Thus, with the introduction of television, the end of the radio and of cinema was proclaimed with certainty. And with the advent of hypermedia and computers, the death of the book seems inevitable... Or does it?

Although technology is not the determining factor in changing society, it is nevertheless a contributor to social change. While new information technologies like hypermedia may open up new opportunities in the realm of human communication and information exchange, whether we choose to follow up on these or not is up to us. Being in control does not mean that we are immune to its influences, however, but rather that we cannot always foresee or accurately predict the consequences of our choices.

If indeed hypermedia is to be the "fourth revolutionary cognitive invention" of humankind, (Harnad, 1991) it seems appropriate to take a look at the first three in terms of what they have meant to the development of human communication: language, writing and print.

3.1 language

> **Speak that I may see you. (Salen, 1993)**

The first cognitive revolution believed to have had a fundamental impact on the development of humankind is the invention of language. It permitted humans to communicate ideas verbally, to externalize and share what had been internal through an "oral codification of thought". (Harnad, 1991)

Speech imposed limits on the exchange of information which could take place, however. People involved in a dialogue had to share both location and time, as well as a mutual sharing of the code used in the act of verbal communication.

3.2 writing

> **In becoming less interactive, writing also became less spontaneous than speech, more deliberate, and more systematic. One might also say it became less social and more solipsistic, although its ultimate social reach became much larger, limited only by the slow pace of copyists in providing the text to disseminate. (Harnad, 1991)**

As with language, writing enables an externalization of thought, but it also fixes these thoughts in material form, enabling a break from the originator of the ideas, the human source of the information. With writing, Finnegan notes,

> **The past can become something objective and analyzable, rather than a transmutation or reflection just of the present. (1988)**

With writing came the possibility of communicating ideas asynchronously, breaking both the boundaries of time and space. More importantly, writing made possible the accumulation of knowledge in a verifiable format (Finnegan, 1988) by expanding the human memory's capacity to store information onto an external mnemonic device, a development which did not please everyone equally:

> **The discovery of the alphabet will create forgetfulness in the learners' souls because they will not use their memories; they will trust to the external written characters and not remember of themselves... You give your disciples not truth but only the semblance of truth; they will be heroes of many things, and will have learned nothing; they will appear to be omniscient and will generally know nothing.**
> **(Socrates, in Plato's *Phaedrus*)**

3.3 print

> **Print situates words in space more relentlessly than writing ever did. Writing moves words from the sound world of visual space, but print locks words into position in this space. Control of this space is everything. (Ong, 1988)**

With the invention of the technology of print (made possible by movable type and the printing press in the fifteenth century) the dissemination of the written word was accomplished on an unprecedented scale.

With print, mass communication came into being, and author and reader were further separated in a seemingly impersonal environment of information exchange which no longer dealt with people interacting directly with people, but rather with people interacting with the technology itself in order to extract meaning from its fixed, unyielding form. According to McLuhan, print contributed to our moving from an auditory mode of understanding to a primarily visual one by fixing meaning into an artifact rather than negotiating it in a face to face context. (1962)

3.4 hypermedia

> **We can understand both our present industrial society (based on printing and writing) and the society of the future (based on telecommunications) towards which we are developing in terms of the dissolution of space, the new political and economic possibilities, the 'mass' emphasis... And perhaps the mental and emotional development which can all be attributed to modern telecommunications. (Finnegan, 1988)**

Chapter 3

One cannot speak of hypermedia as the latest and possibly greatest cognitive development of humankind (Harnad, 1991) without recognizing that it is simply the latest development in the pool of technologies which first enabled synchronous communication at a distance: telecommunications.

Telecommunication media like the telephone (fax machines), radio, television, and more recently computers (e-mail and hypermedia) have all contributed to our need and expectation of speed – often to the detriment of quality – in the transmission of information. Telecommunications have made possible the practically instantaneous exchange of information across vast distances in a mostly non-fixed form (tape recordings, records and CDs being asynchronous exceptions). What differentiates the World Wide Web from other telecommunication environments is that several individuals can theoretically partake in a simultaneous, interactive exchange of multimedia information. Distance has ceased to be important in the context of direct human communication since, as Finnegan remarks, "we can see or hear of far-off events as they take place." (1988)

Chapter 4 taking the hype out of hypermedia: *a perspective*

> **The relation of the new to the old, before the assimilation is performed, is wonder. (W. James)**

We are being surrounded every day with claims that the World Wide Web is possibly the single most important development in telecommunications to have taken place in this millennium. As little as five years ago, few people had ever used the internet, the World Wide Web, or even heard of hypertext. What, then, has come over us and turned hypermedia into such an overnight success?

4.1 an overnight success?

According to Larry Keeley, there are at least three factors which have made hypermedia popular in our society:

1. its technical feasibility
2. our time perception
3. the phenomenon of demassification (1990)

There is an additional factor which, in my opinion, contributes to the popularity of this technology: hypermedia is impermanent, thus enabling us to be non-commital.

4.1.1 technical feasibility

Hypermedia's popularity can be attributed to its technical and economical feasibility. (Keeley, 1990) Unlike Bush's Memex which could not be built because people had not developed the technology yet, hypermedia is now possible because hardware and software developments have made it so. The prices of computers and software have drastically dropped and continue to do so, now making it more possible than ever to have access to a computer, be it at the library, the community centre or even at home.

4.1.2 time perception

A factor Keeley mentions in having a positive effect on the eager adoption of hypermedia technology is our conviction that we simply do not have any time to waste. (1990) As such, the instantaneous access, the sheer speed of information exchange across space and time is definitely appealing to a society which is obsessed with maximum efficiency through minimal exertion. When faced with such instantaneous feedback, however, we need to take a step aside and get a clear view of what is happening. We need to ask

ourselves: does the fact that we do it faster necessarily make it better? Sless warns that:

> **Greater carrying capacity will not of itself lead to better communication, only faster and bigger misunderstandings. (1994)**

4.1.3 demassification

According to Keeley, hypermedia's popularity can be in part attributed to the concept of "demassification" (1990): we like the idea of customization, of having things which are different from everyone else's. As such, hypermedia enables us to reconfigure at will our information environment. For instance, in a Web site, a person may change such things as the order in which the content is accessed, the typeface in which the information is displayed, the colour of the text, background, and even whether the site will be read as a text file or experienced as a multimedia document.

4.1.4 being non-commital

A factor which I consider to be crucial in making hypermedia so desirable is the opportunity that hypermedia offers us to be noncommittal. As Paul Zelevansky notes,

> **Erasing an error or imperfection is never quite as clean and complete as when it happens on the screen. (1991)**

In a society where decisions have to be reached quickly and efficiently, where we are told to create a Web site and put it on-line before it is too late, it is comforting to know that it can always be reworked, updated, corrected, and even removed should we wish to do so. Indeed, the World Wide Web is in a perpetual state of construction and deconstruction as a result of hypermedia's impermanence.

Unlike the technology of print, in which we must commit to what will be preserved physically for generations to come, hypermedia imposes no such demands on the author. In fact, the very nature of the technology enables people to constantly revise and update what they are communicating. If they did not, they might as well have had their information printed. This is why on the World Wide Web, there is no such thing as a finished product, but rather a process in progress. This is an important point to mention since it will affect how we deal with information in the future. Traditionally, a literate society preserves its information in a mostly material form, whether it be a stone

carving, a manuscript, or even a poster. The creation of an artifact requires commitment to ideas which will be preserved for future generations, defining cultures which in turn influence the cultural artifacts that are created.

4.1.4.1 orality

> **Compared to printed text, hypertext[media] suggests integration and openness rather than self-containment. But precisely through this openness, it loses the quality of containing a truth, a definite message. The text is not a definite thing or object, but more like oral, evanescent utterances that constantly appear and vanish in flows of voices. (Rasmussen, 1995)**

Hypermedia contextualizes human communication into an oral, rather than literate framework. When speaking of "oral" cultures, Finnegan describes the transmission of information in a context which is applicable to hypermedia systems:

> **An oral – unlike written – account can easily be bent to fit present political realities, and (failing an outside written record) there is no documentary evidence by which it could be proved to have changed. (1988)**

4.1.4.2 :-)

While print fixes meaning into a rigid form, hypermedia allows us the freedom to rephrase, reorganize and perhaps more importantly, to interact and respond on an informal level which simultaneously promotes dynamic exchange and a perceived loss of value in what we are exchanging. An interesting phenomenon to emerge from this intangible, reconfigurable and thus forgiving environment is the acceptance – and anticipation – of spelling errors which are abundant in most digital communication transactions such as e-mail messages, newsgroup postings and Web sites.

In addition to these unintentional mistakes, an alternative language has slowly emerged from this so-called cyberculture which is based on acronyms as means of reducing the amount of typing required to convey information to another person involved in the interaction. Building on the diminutive language one finds in the newspaper classified advertisements, we encounter on a daily basis such words as: ROTFL ("rolling on the floor laughing"), IMHO ("in my humble opinion") and WYSYWYG ("what you see is what you get"). In addition, a need has arisen from the seemingly impersonal digital

environment to communicate emotions using "emoticons" (also known as "smileys") which use typographic characters to simulate human expression:
:-) happy >:-(angry (:-(sad :-/ skeptical

4.2 characteristics

In order to create meaningful hypermedia systems, it is important to consider its characteristics in terms of how they can be emphasized when designing and implementing hypermedia-based systems such as Web sites. Hypermedia's strong points are believed to be: multilinearity, interactivity, associativity, flexibility and efficiency.

4.2.1 multilinearity

Hypermedia is multilinear in that the informational content can be accessed in different ways, based on people's differing needs and strategies. According to Marchionini,

> **Allowing learners to decide the pace and sequencing of navigation offers them opportunities to accommodate their individual differences and not only to learn course content but also even to learn how to learn. (1988)**

Thus, when creating a Web site based on existing printed material, for example, it is important to avoid the common mistake of directly translating the written document into something which is simply readable on the World Wide Web. To do so is to deny one of the fundamental differences between print and hypermedia: print imposes a sequence, whereas hypermedia breaks it. The challenge therefore lies in preserving the integrity of the content while adapting it to a new information technology.

4.2.2 interactivity

> **Designers need to focus on what it means for media to be interactive. The telephone is an interactive medium that has revolutionized communications. Phones have poor bandwidth compared to live interaction; you can't use them to send video, gestures, or even music with full dynamic range. But this quality is paradoxically a major factor in the success of phones. They are a great device for concentrating on human conversation. (Keeley, 1990)**

The concept of interactivity is directly linked to multilinearity and is well worth emphasizing. Interactivity enables a person to play a pro-active part in the exchange of information, not only with the system, but with other

people as well. By directly interacting with other people, the communication becomes richer, and the information often undergoes changes as a result of the interaction between people and becomes that much more meaningful.

4.2.3 associativity

An important aspect of hypermedia is its associative nature. This, according to research, is a strong point in its favour since hypermedia is believed to simulate how human memory works in that it logically and symbolically organizes information which is linked together in a network. (Liu, 1994) The fact that it apparently mimics certain human functions, however, does not necessarily make it intuitive. To take advantage of hypermedia as an information technology, we must guide people in how to use such a system in order for it to be useful. Ironically, it appears that we need to be taught how to use intuitive technology.

4.2.4 flexibility

An aspect of hypermedia which plays in its favour is its inherent flexibility. Different levels of complexity can be easily introduced in an information system which would be more inconvenient to do with traditional technologies like print. (Liu, 1994) Hypermedia also lends itself well to accommodating different types of learning behaviour. Thus, instead of having a course book to which everyone must adapt, a hypermedia system has the potential to accommodate different needs, intentions, and cognitive styles, and it is in its capacity to accommodate these needs that hypermedia finds its strength.

4.2.5 efficiency

Hypermedia is an efficient technology. In a multimedia document, for example, sound, images, video and various other media can be brought together with relatively little effort. This information can in turn be made simultaneously accessible to the person seeking the information since all the data resides in digital form. The important thing to remember, however, is that when developing hypermedia systems such as Web sites, a distinction must be made between useful multimedia and useless clutter.

4.3 concerns

> **Choice implies freedom; interaction promises power. Where within the multiplicity of competing ideas does someone acquire the tools to make judgments and decisions? (Zelevansky, 1991)**

When introducing a new technology in the context of human communication, questions inevitably arise as to not only what tasks it will facilitate and what information environments it will enhance, but also how many unanticipated problems will arise as a result, and whether we are conceptually equipped to deal with them. Unfortunately, the latter concerns often tend to disappear behind a wall of enthusiasm put forth by the new technology's proponents.

Among the concerns which have recently surfaced about hypermedia-supported communication environments, we can distinguish those which relate to the technical implementation limits from those which refer to the theory and application of the new technology. While technical concerns are for the most part temporary setbacks which will soon disappear with an improvement in technology, concerns which revolve around how we understand and interact with a new information technology demand careful consideration since they are less likely to disappear behind a cloud of technological innovation.

Whereas technical considerations apply to hardware such as input and output devices, cognitive considerations apply to people.

4.3.1 disorientation

Rather than facilitating the gathering of information, hypermedia can in fact hinder it. Disorientation in a hypermedia system often occurs when a person delves into the information structure so deeply that they lose all context of location, forget how they got there, and therefore cannot decide where they want to go next. On the concern of disorientation, Michels remarks:

> **Of course, a disorientation problem also occurs in traditional linear documents. But in a linear document a reader only has two options: [s]he can search for the desired object further on or earlier in the document. The hypermedia mode offers more freedom, more dimensions in which the reader can move, and hence a greater potential for him [her] to become lost or disoriented. (1994)**

A relatively simple solution to decreasing disorientation in hypermedia systems lies in restricting the number of links a person can follow at any given time and to describe the nature of these links so that one knows what lies ahead without having to follow a link. As a result, navigating through the informational content of a hypermedia system becomes a meaningful activity rather than a haphazard treasure hunt.

4.3.2 cognitive overhead

> **Without sufficient guidance, learners, particularly novice learners, facing a number of choices about which links to follow and which to leave alone, experience definite distraction that degrades the effectiveness of learning. (Zhao et al, 1994)**

Related to the concern of disorientation, there is the problem of mental effort – often referred to as cognitive overhead – required to use a hypermedia system. (Conklin, 1987) This is directly related to what was earlier perceived as a positive aspect: multilinearity. With no directed action, predetermined sequence, and innumerable choices to be made at every turn, we run the potential risk of creating a form of "intellectual indigestion" for the participant. (Dede & Palumbo, 1991)

Not unlike the problem of disorientation, cognitive overhead can be reduced by designing hypermedia-supported environments which focus people's efforts on following meaningful links rather than offering endless possibilities.

4.3.3 control

"User control" refers to the fact that in a hypermedia environment, a person is responsible for their learning. As such, they must decide which information is relevant to them, which is not, and the order in which to access it. This aspect of control on the part of the participant rather than the author is often emphasized as being a positive aspect of hypermedia-supported systems, but it makes an erroneous assumption that all people are alike and learn in the same ways. In fact, people have different cognitive styles and exhibit different learning behaviour resulting in different needs. As Jonassen points out:

> **Because of its highly interactive nature, a hypermedia environment places a large amount of responsibility on the learner. However, research shows that not all learners can benefit from this less structured learning environment. Some actually produce less satisfactory results. (1989)**

Chapter 5 the fate of the book: *death of an artifact?*

> **Numerous experiments have shown that if a configuration is encountered which is not conventionally interpretable, which has no semantic function, which cannot be categorized by some existent categorical system, the perceiver cannot tolerate such a degree of cognitive tension and forthwise makes sense out of it, makes it meaningful, by assigning it to the range of an existent category, even when such assignment is wildly inappropriate. (Peckham, 1966)**

In an attempt to understand a new technology, we often resort to using metaphors – in this case print – in order to make sense of a new and unfamiliar situation. In turn, many of the problems that arise when designing hypermedia systems can be traced back to our print biases and the restrictive framework they impose on our perception of the new technology.

These same biases are what lead many people to proclaim that the end of the book is near, that it will be displaced, finally that it has reached the end of its reign as the primary information disseminator and must gracefully bow out. As Finnegan notes, the impression appears to be that "new technologies inevitably oust the old." (1988) Could this be the case with one of our most cherished artifacts, the book?

Throughout the history of literate society, we find records of information that was deemed important enough to warrant preserving it in some material form. The effort required to record information in writing is significant: both from a material point a view, as well as from an educational and economic one. What, then, shall we make of the information which exists in hyperspace? What value can be placed on information which is fleeting and endlessly reconfigurable?

5.1 comparing print & hypermedia

Crucial to understanding what could become of the book in a seemingly digital-driven information society is our capacity to distinguish between such tasks as storage, transmission and communication. Whereas a storage device is intended primarily to hold information and preserve it for future retrieval, a delivery system's purpose lies primarily in transferring information from one point to another.

What distinguishes a communication environment from either a storage device or a transmission system is its semantic value. A communication environment creates a meaningful context for information exchange which requires a person to become actively involved with the content in order to

extract meaning from it. Both print and hypermedia support all three categories of tasks and often the divisions between these become blurred.

5.1.1 storage

Many people start comparing books and digital media in terms of information storage. Print in its material incarnation of the book is essentially limited in the amount of information it can store. In comparison, hypermedia systems can hold vast amounts of information which do not occupy the physical space that would be required to store the same information in print form. Maran notes, for example, that to store one gigabyte of information (1,073,741,824 characters) would require approximately one thousand novels (1996). To hold the same amount of information in digital form would require significantly less space by storing it on a computer hard drive or a removable disk.

Moreover, hypermedia technology does not require the content to be stored in its entirety in a single location. Since the definition of a hypermedia system involves a computer-supported network, the information itself can be spread out through the various interlinked computers without compromising the integrity of the information system or its accessibility. On the other hand, a print-based information system such as an encyclopedia does not allow the division of its components.

5.1.1.2 retrieval

Stored information would be of little use if it could not be retrieved. While this may seem obvious, information retrieval is at times problematic when dealing with digital storage. Retrieving information from digital source requires additional peripherals. If the information has been recorded onto a CD-ROM, it cannot be extracted without electricity, a computer, a CD-ROM drive and software. Interestingly enough, information retrieval from digital storage is problematic primarily because of its diverse material qualities. Although the information itself is apparently "non-physical", it nevertheless needs to be materialized in some fixed form in order for it to be usable. It is this material aspect which carries significant accessibility problems which may eventually make information retrieval nearly impossible within a few years of its archiving. For instance, trying to access information from a 5.25 inch floppy disk has become increasingly difficult as the technology for which it was originally created is no longer being produced. It is important to note that the obsolescence lies in the material (medium) rather than in the technology itself. Complicating matters further is the issue of platform-

specific devices which generally cannot be retrieved without the corresponding hardware.

In the case of information which is recorded in book form, it is both self-contained and self-sufficient. A book can be opened and the content can be read directly from it, with no additional technology required to access the information contained within the pages. Regardless of the book's age, its contents can be read in the same manner as it was when the book was first printed. This is a significant advantage that print-based information systems hold over hypermedia-based systems. While it is true that we have no direct access to print without going through the book, access to a hypermedia system is increasingly complex due to the technological requirements imposed on it.

5.1.2 transmission

When comparing print-based systems with hypermedia-based systems in terms of disseminating information, the advantages of digital media are evident. The speed of transferring information through a computer network rather than through print-based media holds the advantage of enabling a practically instantaneous and interactive exchange of ideas between people across time and geographic boundaries. Furthermore, when dealing with hypermedia systems such as the World Wide Web, the same information system can be accessed by numerous people simultaneously in different locations.

5.1.2.1 from book to hyperbook

As a result of the speed and convenience of exchange which hypermedia-supported systems provide, there has been an increasing urge to translate printed documents into digital form. This has been particularly true in the context of the library conservationist agenda where preserving slowly disintegrating books for future generations has become an increasingly challenging task, both economically and in terms of required space. What must be mentioned, however, is that not all printed documents are suitable for hypermedia conversion. Whereas reference materials such as dictionaries, encyclopedias and training manuals may benefit from hypermedia technology (Balasubramanian, 1994), novels most certainly will not since the latter impose a definite linear sequence to the information and demand a substantial time commitment to reading from the computer monitor.

5.1.2.2 from hypermedia to print media

It is interesting to note that while efforts have been made to convert printed text into hypermedia systems, the reverse is just as popular. Indeed, our culture is so deeply rooted in the book that we often find it difficult to access information purely on-line without resorting to printing the document in order to read it in a familiar form. This rarely poses a problem when dealing with hypermedia systems which have been primarily designed as linear text documents. As the hypermedia system becomes more fragmented and multilinear, however, it becomes increasingly difficult and inappropriate to produce a coherent printed version since it was not originally designed to be accessed through a traditional medium.

5.1.3 communication

At the heart of information systems lies the interaction a person has with the content and how, in turn the person creates meaning from that interaction. The book is linear in nature, hypermedia is not. As Ong notes: "Print encourages a sense of closure, a sense that what is found in a text has been finalized, has reached a state of completion." (1982)

Despite the Modernist ideal that a book should be a transparent vehicle for thought, our involvement with books goes beyond merely the conceptual accumulation of knowledge. We interact with books on all levels: physical, syntactic and semantic. The book is more than simply a material channel for print, it embodies a cultural ideal and a sensory involvement which make it as much an artifact as a container for information. In contrast, a hypermedia system is theoretically infinite, intangible and fleeting. It has no odour, texture, sound, or even look that cannot be altered by pressing a key or clicking a mouse. Since hypermedia systems are essentially device-independent, they are constantly reconfigurable and change according to the individual's needs and the hardware itself. As a result, a hypermedia system appears to be information in its purest form, uncluttered by any materialistic embodiment. This intangibility, however, is the reason why we mistrust it. Hypermedia has no substance, permanence, and thus cannot be verified, qualified, or even engaged with on the same level as print:

> **Reading implies a commitment that clicking a mouse or scanning with a TV remote does not. (Zelevansky, 1991)**

5.2 the future of print

> **Hypertext[media] means the end of the death of literature.**
> **(Moulthrop, 1991)**

Hypermedia does not spell the end of the book. In fact, since most hypermedia systems "remain rooted in the culture of the word" (Bukatman, 1995), it could be said that hypermedia re-establishes literacy to a level that was claimed to have been lost with the advent of television. Most of the content on the internet is text-based. Furthermore, due to technical limitations (although admittedly temporary) much of the World Wide Web's content remains mostly text-based with sporadic outbursts of multimedia.

As physical beings, our need for materialistic artifacts is too great to give up on such a whim. As literate beings, our yearning for closure and our familiarity with print technology are too important to abandon. We are not yet ready to give up on books, and therefore we will not. As Horowitz points out, in an age of television and computers, we produce more books each year than ever before (1986), many of which, ironically, deal with new information technologies.

Much like television did not signal the end of the motion picture, hypermedia does not forebode the end of print. Besides, we cannot speak of one technology taking over another when both offer unique qualities that the other cannot possess:

> **To speak of a war between the visual and the written is totally passé. We now must, on the contrary, analyse the synergy between the two.**
> **(Eco, 1991, in Kessler)**

The best way to live with our limitations is to know them. (E. J. Dijkstra)

The potential the World Wide Web as a hypermedia system holds for human information exchange is considerable. Why, then, is it such a disappointment to most of us?

At the root of the problem we find our deep involvement with the technology itself. We are all captured by the promises, but seem to have forgotten that people created the World Wide Web to satisfy a need, and that need is to exchange information with other people regardless of geographic location or time constraints.

The first step towards humanizing the World Wide Web, therefore, lies not in trying to change the whole, but rather in designing usable and useful Web sites and recognizing that the strong point of the World Wide Web lies in its potential to serve as a hypermedia vehicle through which we can communicate content and exchange information with one another.

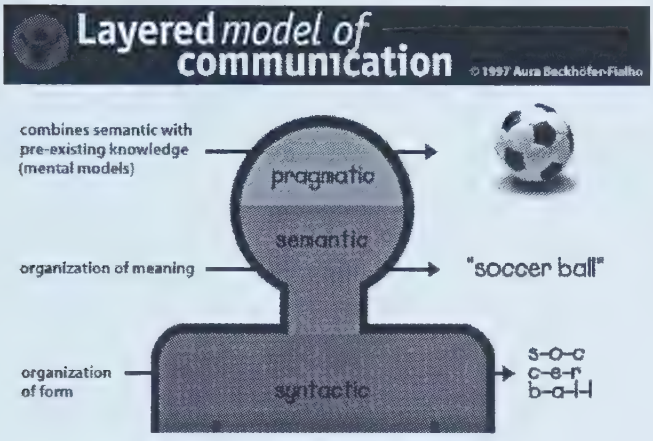
> **If there were an opportunity for graphic design to be more involved with content, the World Wide Web is it... Content instead of form is what ultimately may come to differentiate and qualify Web sites. However... Judging a Web site on the strength of its content will not soon gain popularity, at least not within the narrow world of graphic design. Unless, of course, you expand the notion of what graphic design is. (Vanderlans, 1996)**

6.1 semantics

In order to better understand how people extract meaning from information acquired in a hypermedia-supported system, we must turn our attention to the world of semantics and the model of layered communication which can in turn be adapted to a human-computer-interaction environment.

6.1.1 layered communication model

The model of layered communication states that for meaningful communication to take place, it must occur on three separate – and yet often simultaneous – levels. The first is the syntactic level which concerns itself with the organization of form, pattern recognition and stored definitions. The second level, termed semantic, deals primarily with the organization of meaning. The third layer, the pragmatic level, combines the semantic interpretation with the preestablished knowledge a person has of themselves and their environment. In reading, for example, a person moves from the syntactic level, where

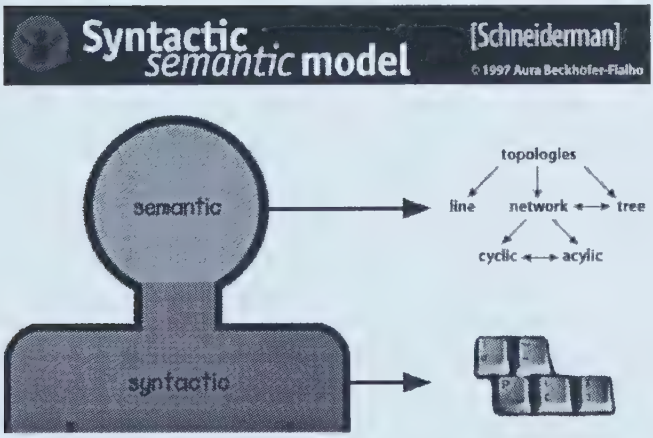


they define individual words and iden-tify sentence structure, to the semantic level, where the meaning of the sentence is extracted, to the pragmatic level, where the information is interpreted in relation to a person's context and existing field of knowledge and is understood in terms of relevance.

How can the model of layered communication be applied to hypermediated communication? We could start, as Ben Schneiderman suggested, by simplifying the model and looking at two combinatory levels: the semantic and the syntactic. (1987)

6.1.2 syntactic/semantic model

In the context of human-computer-interaction, we can attempt to comprehend how information is understood and in turn processed by using the syntactic/semantic model of user knowledge proposed by Schneiderman (1987). In brief, the semantic level is described as the level where concepts and mental models are developed. The information processed in the semantic level is structured and made meaningful by its connection to other concepts. Meaningful learning occurs at this level because of its stability in long-term memory. As a result, we can state that any information which is understood at a conceptual (semantic) level is device-independent. On the other hand, information which is processed at the syntactic level is that which concerns itself with the physical and formal interaction with the system. At this level, the information is varied and constantly readjusted. It is usually information which is not understood as much as memorized, making it unstable and easily forgotten. Information processing at this level is device-dependent. Rather than dealing with conceptual mental models, we are dealing with unrelated details. An example



of syntactic-level information would be that of memorizing a sequence of keyboard characters to execute a command in a particular software application.

Using the syntactic/semantic model of user knowledge, it becomes clear that in order to create a meaningful context for information, it must be structured in a semantically-meaningful way. To carry over the understanding of communication models into the practical realm of developing hypermedia systems, however, it is necessary to delve into the theory of semantic networks.

6.1.3 semantic networks

The theory of semantic networks states the following:

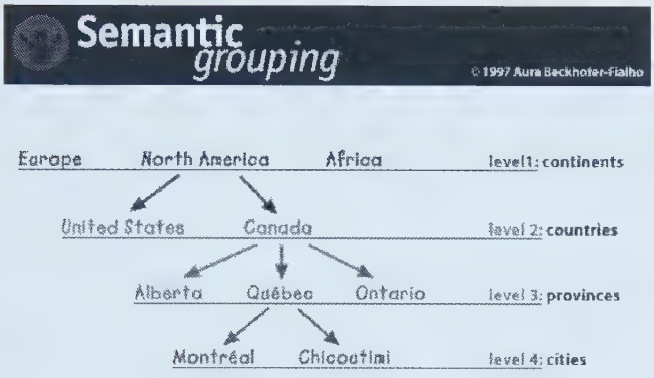
1. Human memory is associative
2. The interrelatedness between ideas are depicted by nodes and links. (Liu, 1994)

A semantic network is a conceptual representation of how people organize knowledge in their memory. (Conklin, 1987) A semantic network, in the field of cognitive psychology, is represented by a network structure of nodes which symbolize concepts and links which represent the relationships between these concepts. (Zhao et al, 1994) The analogy between semantic networks and hypermedia technology is one that is often referred to when discussing organizational strategies for hypermedia systems. Based on the assumption that human memory utilizes semantic networks to organize and understand information, it is believed that mimicking such organization in a hypermedia-supported system will lead to better retention and understanding of the material. (Liu, 1994)

Thus, in order to create meaningful hypermedia systems, we must turn to a semantic-network-based hypermedia structure in which concepts are linked through their content rather than being organized in some haphazard order such as alphabetization or numbering. (Liu, 1994) By strengthening the relationship between the various components of a hypermedia system, we make it more usable, and thus more meaningful to the person using it.

6.1.4 semantic hypermedia

To make information meaningful in an interactive environment, the underlying structure must support a semantic grouping of the content. This can be achieved by first creating a top level of information which logically groups



similar items together. The categories which are in turn created must cover all possibilities in the system and should not overlap semantically. A second level of information is then added which corresponds to the top-level categorization, and so on. In addition, using familiar terminology throughout the structure will avoid syntactic processing of information which needlessly forces a person to memorize specific terminology in order to understand the organization of the content. (Schneiderman, 1987)

Even within a semantic hypermedia system, disorientation can occur. This is particularly true of large hypermedia structures in which it is fairly easy to lose the mental model of the semantic organization of the content. Indeed, one of the strengths of hypermedia, that of multilinearity, is also one of its weaknesses in that it necessarily imposes a fragmented access to the information resulting in a tunnel-vision effect where it becomes increasingly difficult to understand the overall pattern and the relationships between concepts. This is where choosing an appropriate topology can re-establish coherence in a seemingly random information structure.

In order for information to become meaningful, it must exist within a context and this context in turn must be easily understood and easily navigated. When speaking of navigating through a hypermedia system, I refer to the actions that enable a person to move from one document to the next within the information network. Navigation is an important issue when discussing the design and development of usable hypermedia and is a deciding factor when designing the interface through which people will access the information.

6.2 designing hypermedia

> **In order for design to be effective as a communication tool, it is necessary for designers to realize their task in the realm of meaning, not aesthetic form. To think the reverse implies that when we speak we think in terms of grammar rather than in terms of what we want to express. (Salen, 1993)**

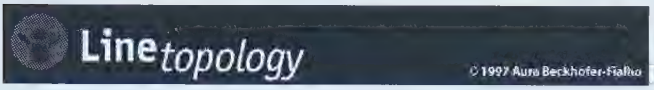
To create a coherent hypermedia-based information environment, we must address the concerns of the person seeking information. These concerns mostly revolve around the questions of navigation and location: "Where am I? How did I get here? Where can I go? Where have I been? How do I move on?" (Keeley, 1990) The challenge for the designer lies in creating an interactive system without compromising the semantic organization, and thus meaning, of the information. This can be attempted by focusing on three areas: strategies, topologies and interface design. (Keeley, 1990)

6.2.1 strategies

A person who is browsing has different intentions than a person who is seeking specific information. (Keeley, 1990) Ideally, the hypermedia system should be designed in such a way as to accommodate different strategies, anticipated or not. This will result in the information environment being truly flexible, not only from a system perspective, but also from a person's standpoint in that it can easily accommodate different intentions and levels of sophistication.

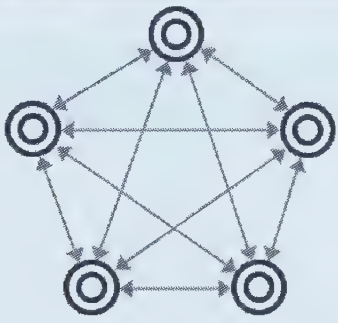
6.2.2 topologies

At the root of designing meaningful hypermedia systems which reduce mental effort lies the necessity to structure the information in such a way as to facilitate navigation through the content. In other words, to organize the network itself by choosing a topology to structure the system's content and address navigation options in a consistent manner. A topology is a method of organizing information following a predeter-mined structure denoting the sequence, hierarchy and interrelationship of the different components of a system. There are several topologies which are currently used to organize information among which we find: the line, web, tree and network.



6.2.2.1 line

The line topology is perhaps the one with which we are most familiar. It is a non-hierarchical sequential structure in which nodes follow each other in a linear fashion. The line topology depends on there being a definite beginning and conclusion to its content development. Traditionally, novels exhibit a linear topology of information organization.

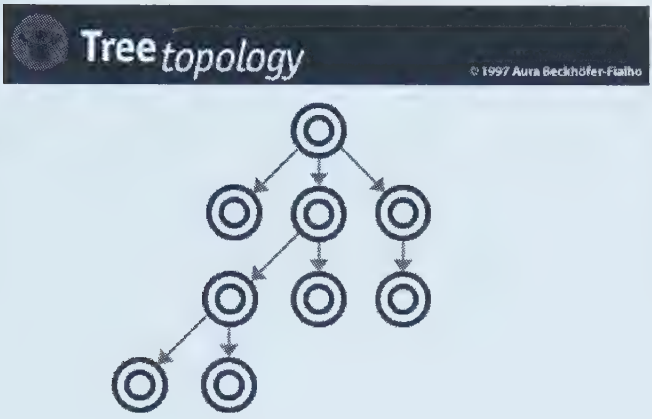


6.2.2.2 web

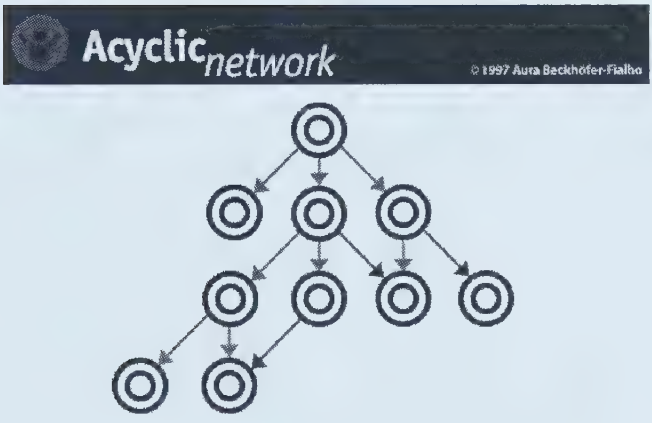
The web topology, also confusingly known as the net, is a popular topology in which all nodes within the system are interlinked. It is a truly non-sequential, non-hierarchical topology, thus making it a modular one as well. In this type of organization, although the nodes are all interconnected, they also stand independently from each other. While this topology is the structure which most often represents hypermedia systems, it is also the one which holds the greatest potential for disorientation. The World Wide Web is an example of using the web topology to organize content.

6.2.2.3 tree

Perhaps one of the most widely used topologies in hypermedia systems is the tree. In this structure, the information is organized in a hierarchical, pyramid-like formation which contains nodes and links structured using levels of depth and breadth. Following a link leads to additional options which branch out, eventually leading to a dead-end which forces a person to backtrack in order to get back to a higher level of information which will allow more lateral movement. The advantage to using a tree topology revolves mainly around its meaningful organization of content. By restraining lateral movement among documents, this topology imposes a recontextuali-



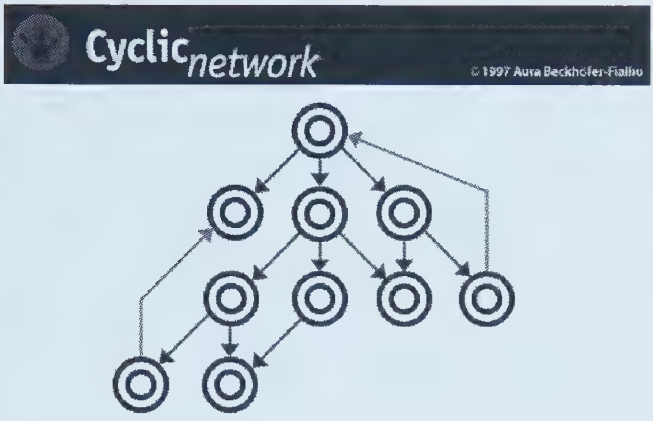
zation of the information with every link followed. Since it is a hierarchical structure, the tree topology carries with it the potential for heavy cognitive overhead at every level of information and with every link followed deeper and deeper down a particular path (or branch). In order to minimize the effect of disorientation, the tree topology should restrict its content depth to four levels and its level breadth to four to eight items, depending on the semantic relationship between the items. (Schneiderman, 1987)



6.2.2.4 network

The network structure builds upon the tree topology by offering lateral linking across branches. Like the tree, the network topology is hierarchical. This type of structure currently exists in two variations. The first, called the acyclic network allows cross-referencing with lower-level items.

The other, referred to as the cyclic network enables lateral linking with both lower-level and higher-level documents. The advantage of the latter is obvious: it provides meaningful context by structuring the information in a hierarchy (like the tree topology), while allowing cross-referencing throughout the system when semantically significant relationships are to be explored.



6.2.3 interface design

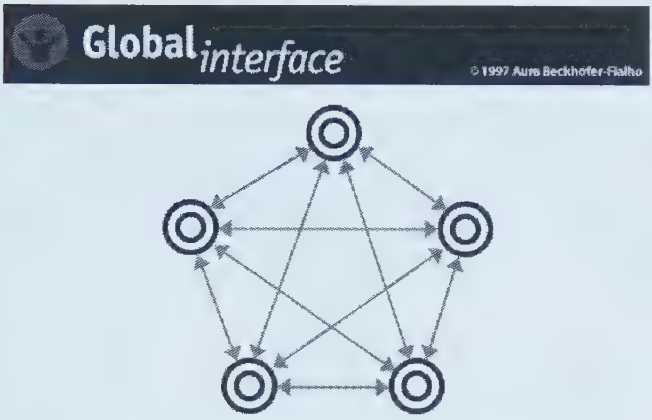
It is misleading to want to capture the nonscientific aspects of interfaces and particularly design aspects of interface as 'art'. That notion evokes an aura of mystery and inexplicability that might be avoided by simply talking about interface design. (Bonsiepe, 1990)

Interface design goes beyond the aesthetic concerns by controlling the interaction between person and system. In Frank Maddix's – somewhat anthropomorphic – statement:

> **An interface is a channel of communication between two partners in an interaction. (1994)**

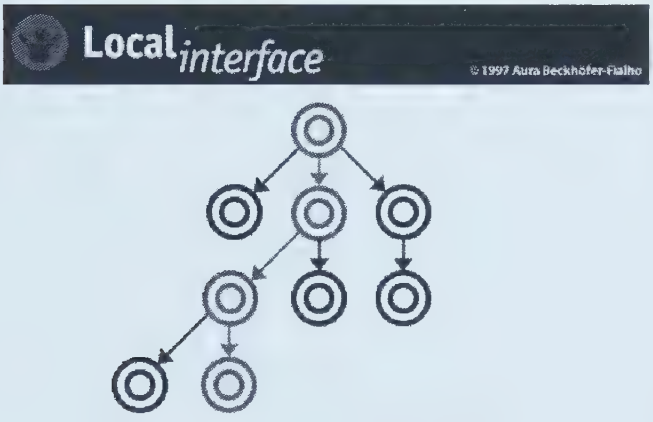
As such, it should ideally hide the complexity of the underlying structure and help the person in creating a mental model of the network. Once the issues of strategies and topologies have been addressed, the next stage necessarily involves creating a bridge between person and system; to create a visual representation of the structure and content so that people can access it in a meaningful way.

Effective interface design not only appeals to a person's sense of aesthetics, but more importantly, lends itself to being a meaningful environment for the interactive exchange of information between the participant and the hypermedia system's author(s). It is the interface which gives a hypermedia system its character, look and feel. It is also the interface which determines how the audience will interact with the information, and how this information will in turn be understood. The key to effective interface design lies in anticipating who the target audience is and providing them with an intuitive means of accessing the information. The important point to remember is that while dazzling displays are initially intriguing, surface glitter quickly fades to annoyance when it hinders the communication process.



6.2.3.1 local & global interfaces
There are two distinct interface design strategies which can be identified when designing hypermedia environments: global and local.

A global interface allows the person to see (and therefore jump to) all the nodes which are semantically linked in the system. (Lidwell et al, 1994)



The local interface on the other hand, requires that a person select the "correct" semantic relationship between a limited number of nodes. (Lidwell et al, 1994) In the context of hypermedia systems and semantic meaning, the local interface has significant advantages over the global interface, in that it reduces cognitive overhead and navigation load while supplying directed interaction. This, according to the syntactic/semantic model of user knowledge, promotes a deeper processing of information to take place, thus promoting a deeper level of meaning to evolve from the direct interaction with the information.

6.2.3.2 aims
As a bridge between person and system, a "shared environment of representations" (Nadin, 1988), the interface of an effective hypermedia system must:

1. focus attention
2. develop and maintain interest
3. promote understanding
4. facilitate navigation and orientation (Tilley Merks et al, 1995)

6.2.3.2.1 focusing attention

Arguably the most important concept to remember when designing the interface for a hypermedia-supported system is to maintain a simplicity of design. A clean and uncluttered interface will establish a clear communication environment where a person can focus on the task at hand rather than be distracted by extraneous details. The intention behind a simple design lies in reducing distraction and thus reducing the probability of disorientation and mental effort required to navigate through the information.

Simplicity of design can be achieved by designing a grid, using white space and establishing a visual hierarchy for the displayed information. A grid provides a fixed structure where important features and specific information are located predictably. By adhering to a grid system, a meaningful context is established for the location of various types of information on the screen. If multiple grids are used within a hypermedia system's interface, they should visually reinforce the organization of the content rather than simply add novelty.

Not unlike the grid, the idea of white space is often an overlooked, misunderstood concept which has been carried over from the technology of print. White space is important in helping a person focus their attention on a particular area of significance.

Both the use of a grid system and white space are means by which designers can establish a visual hierarchy of information. Various levels of semantic relevance can be categorized through placement, attributes such as colour, texture, shape, size and behaviour. Thus, navigation devices can be easily identified as such and interpreted differently from other levels of information.

6.2.3.2.2 developing & maintaining interest

As means of reinforcing a sense of location within a vast network of information, a need arises to vary the composition to inform a person of their position and to spark interest. This should be done in moderation within the established grid system so as not to develop an entirely novel interface at every level of the hypermedia system's structure.

Interest can also be fostered by exploiting the interactive potential of the technology by placing the emphasis on active decision-making, rather than linear development of content. In doing so, the person becomes a participant

rather than a passive onlooker. It is important to mention here that the advantage of a person being in control of their information gathering holds potential risks in that some relevant information may not be called upon. In addition, some may feel overburdened by constantly being in control of their informational environment, and would gladly give it up in exchange for a more traditional, linear presentation of content.

The drive to push a new technology to its limits in the name of interest often proves disastrous in a communication setting where the meaningful exchange of information often gets obscured by excess. Thus, hypermedia's capability to support multimedia is both a blessing and a curse. Ideally, sound, animation and film clips should provide the participant with additional information rather than mindless distraction. There is no technological imperative to dictate that since we *can*, we necessarily *must!*

6.2.3.2.3 promoting understanding

When faced with the unfamiliar task of navigating through the information nodes of a hypermedia system, it is helpful to receive feedback from the system itself assuring us that our actions have been registered. Feedback can be designed into a hypermedia system's interface by introducing visual cues which indicate a change of status – such as changing cursor shapes, colour and loading status – responding to a person's actions and in turn reducing frustration and uncertainty.

While visual cues are helpful in providing feedback, restraint must be observed when designing an interface which is primarily iconic in nature. Enthusiastic overusage of icons as navigation and interaction devices potentially create a confusing environment, both visually and cognitively. Often, an easily recognizable word (such as Quit) is far more effective than an innovative icon whose meaning has to be relearned.

Thus, creating a meaningful hypermedia environment in which learning and understanding can take place revolves around reinforcing the semantic relationship between its information nodes and promoting interaction on a semantic, rather than syntactic level.

6.2.3.2.4 facilitating navigation & orientation

The level of understanding and learning which takes place in an information environment relies heavily on the ease with which people can navigate through – and therefore access – the content. In a hypermedia system,

consistency in the interface is of the utmost importance in establishing a set of interaction parameters which soon become "invisible" to the person using it. In particular, consistency of the navigation devices (both in visual attributes and behaviour) must be observed in order to promote and facilitate interaction with the content rather than with the means of accessing it.

Location and context are easy to identify when reading a book. In print, we know where we are at any given point within the information structure by relying on cues such as page numbering and the thickness of the document itself. Lacking the linear sequence which is inherent in print, hypermedia environments do not provide familiar indications as to our location within the system and the context in which a particular piece of information resides. Thus, when navigating through multiple nodes, people need to know at any given time where they are within the system and what options are available to them at that moment.

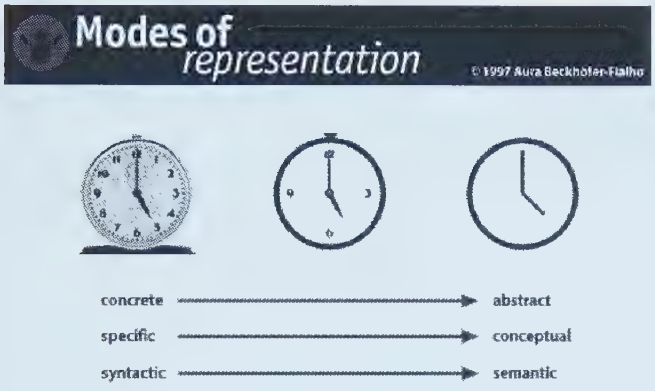
Since these are crucial in establishing a perceived level of relevancy and order, we must therefore address the need to convey in the interface of a hypermedia system a sense of structure and hierarchy. This involves bringing the abstract database of a non-physical environment to a human level where the information can be understood in its relevant context.

Finally, when designing the interface for a hypermedia application, one important point has to be made and that is that no matter how much we think we know about an audience and their needs, we are inevitably proven wrong over and over again unless we start involving people in the design process from the beginning.

> **The most important thing to remember is that the user is never wrong. If they feel it's not good, if they feel it's uninteresting, if they feel it's difficult, then they're right. (J. Mountford)**

6.3 semiotics

Since people cannot physically interact with hypermedia, the interaction must take place through "the intermediary of shared representations" (Nadin, 1988), a symbolic environment of signs we call the interface. Meaningful hypermedia relies heavily on semiotically consistent interface design which in turn relies on representations of objects which symbolize concepts and actions.



There are many ways in which an object can be graphically represented, ranging from the pictographic to the iconic. Pictographic representations are realistic and detailed whereas iconic representations focus on the most meaningful aspects of the object and stylize the less important ones, extracting – and emphasizing – meaning from form.

As we move from a pictographic representation to an iconic one, we move from the concrete to the abstract, from the specific to the conceptual, from a syntactic level of communication to a semantic one. Finally, as we move from the representational to the conventional, we also move from the easily mistaken to the easily recognizable. As the level of detail increases in a representation, so does the level of uncertainty and, to a certain degree, expectation. It is therefore preferable to choose an iconic mode of representation when creating navigation devices and location cues to be used in a hypermedia system's interface since they are easily recognizable and more rapidly processed at the semantic level.

6.4 metaphors

> **For the user the distinctions between a metaphorical world and a 'real' world is of remote interest. The user lives and works in one world, acting with tools, not with metaphors. Therefore... The pictorial elements on a computer monitor don't picture anything, rather they bring forth an action space. (Bonsiepe, 1990)**

Metaphors are a natural part of learning, a way of understanding and coping with a new situation by drawing upon previously acquired knowledge from a similar past situation. As a result, metaphors are unambiguous and reliable by establishing a conceptual bridge between the familiar and the unknown. While metaphors enable people to interact with hypermedia on a familiar level of interaction (such as the desktop metaphor widely used on personal computers), they also create a potentially restrictive situation.

Metaphors ease the transition between old and new, but they also restrict by imposing a predetermined framework on a new situation. While using a desktop metaphor to navigate through a computer's operating system makes the system easier to use because it mirrors a familiar physical environment (in this case, the office), it simultaneously limits how a person can interact with it and what a person may expect to do with it.

Metaphors securely anchor down familiar tasks, such as dragging an unwanted document into a virtual trash can, but do not permit expanding on these beyond what has previously been programmed into the interface. Thus, if instead of dragging a single document into the trash, a person wants to delete all documents which start with the same prefix, their task becomes increasingly complex as they have to accommodate the system rather than having it do what they need it to do. Similarly, while carrying over the print metaphor into hypermedia systems semantically bridges the gap between new and old, it also restricts how people view the new technology and potentially inhibits its unfulfilled potential. Indeed, breaking free from a rooted metaphor such as print is not an easy task. As a result, much of what is currently available on the World Wide Web seldom goes beyond what has been traditionally the territory of print technology: an abundance of text files displayed in a sequential manner, Web sites with linear organization of content, and even direct translations of printed materials such as school course catalogues.

6.5 from the page to the web

The future direction that the World Wide Web will take relies heavily on how we use it in the present. Since it is a vast hypermedia system, we cannot address the whole but rather focus on its parts, and see what we can do to make the communication of our ideas more meaningful to other people. The first step lies in recognizing the particular characteristics of hypermedia technology, what distinguishes it from print, and how in turn we can adapt it to people's needs. The next step involves understanding how people relate to the technology. This necessarily involves questioning. How and why do people interact with computers? What are the psychological effects of communicating through computers with other people? And what are the social consequences of computer-mediated-communication?

While answering each of these questions would be going well beyond the scope of this thesis, the importance lies not in answering these questions, but in asking them. For when we ask the question of how people interact in

hypermediated space, we recognize the fact that people are involved in the process. We are the developers and, more importantly, the participants in a new information technology which sometimes appears to take a life and a momentum of its own. Ultimately, we must recognize that by putting people ahead of the technology, we all gain a deeper understanding and a clearer focus on why hypermedia systems like the World Wide Web could become potentially useful information environments and how we can in turn better use them in a human communication context.

6.6 case study

In 1996, I taught a course in the department of Art and Design at the University of Alberta on design issues as they pertained to the internet. This was a senior-level course which dealt with how the internet could become a useful resource of information for designers and how hypermedia as an increasingly popular technology offered the opportunity for designers to get actively involved in facilitating human communication on the World Wide Web. There were eight fourth year students enrolled in the course and as a final project, we decided to update the department's Web site.

6.6.1 the original web site

The need for a new departmental Web site was twofold. Firstly, the department had a new visual identity which had been recently adopted. As a result, all departmental publications (printed and digital) were expected to form a cohesive visual unity. Secondly, there was a need to restructure the information of the original Web site to make it both more usable and intuitive.

Although the original departmental Web site provided extensive information, the process of accessing it was primarily linear and therefore did not take full advantage of hypermedia features such as multilinear linking and interactivity. In addition, the general feeling was that the site was not representative of the department. In essence, the Web site showed strong print biases both on an interaction and interface level, as well as on a content level.

6.6.2 identifying the message

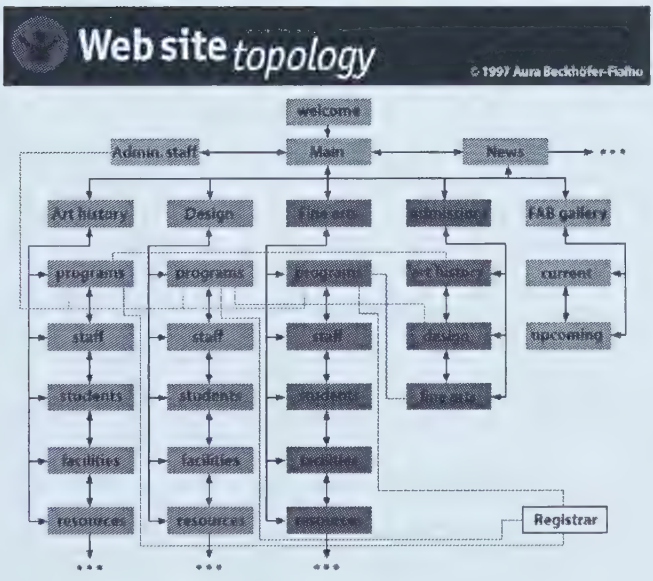
When developing and designing hypermedia systems, the first step is an analytical and organizational one. It is about content and how in turn it can be structured to enhance the exchange of information among people. Thus, prior to separating the class into task forces which would address the visual demands of the interface design for the new Web site, the students and I got

together as a group and analysed the information before us with the intention of making the new system both more usable and useful.

Most of the content for the new Web site was extracted from the original site, although we felt that cutting down on the information was necessary in order to ensure that we had a clear resource of information without eliminating the need for contact between the audience and the university. Concurrently, we discussed who our intended audience was and how in turn we could shape the information to meet their needs.

6.6.3 targeting the audience

Concurrent to developing the content for the new Web site, we identified our target audience: who we wanted to reach and why. This analysis of purpose yielded three distinct groups which we needed to focus on. The first consisted of potential students who were looking for information about programs, admission requirements, and general information about the university. The second target group consisted of people who were in other academic institutions and who were primarily browsing out of academic and professional curiosity. The third group which was identified was the local university population who wanted to keep informed on upcoming events on and around campus.



6.6.4 structuring information

The analysis of our target audience determined how we structured the information for the new Web site. Based on what we knew of the informational needs of our target groups and what we in turn wanted to make available to them, we proceeded to choose a cyclic network as a topology for the organization of the content. This topology was chosen primarily because we wanted to break down the Web site into different categories which related to major areas of interest for the intended audience.

The cyclic network structure allowed for a multilinear arrangement of relevant information within each section, while restricting lateral access to other categories (which nevertheless remained accessible through the home page). This reinforced the context in which the information was accessed, while keeping semantically-similar information organized hierarchically throughout the system.

6.6.5 designing the interface

Once the underlying structure of the new Web site was in place, the class was divided into groups of two students so they could start designing prototypes for the Web site interface. The emphasis was put on navigation issues with the aim of reducing the cognitive effort required to navigate through the information, while simultaneously preserving an acceptable level of interactivity which emphasized the multilinear arrangement of the content. This meant that the interface needed to facilitate and guide a person in finding and understanding the information they were seeking with ease. Unlike designing for print, where designers generally have an idea of who the audience is and, in the very least, know how they will be accessing the information, designing hypermedia systems involves an acknowledgment of the fact that there is no final product for people to interact with. In the context of the World Wide Web, lack of control over such basic elements as choice of typefaces, size, colour and image display capabilities (which are reconfigurable on individual Web browsers) leaves designers with the challenging task of creating dynamic information environments in which flexibility of design is crucial in ensuring widespread access to the information.

In developing the new departmental Web site, we had certain design criteria which had to be carried over from the existing printed material. In essence, we had to retain the look and feel of the new visual identity of the department while adapting it to a new technology which did not easily lend itself to print metaphors. We therefore retained what we considered to be essential features such as the colour palette, the style of the headers, and the display fonts, while adding new features such as colour bars identifying location and context within the site.

6.6.5.1 accessibility

Since we relied heavily on graphics for the interface and navigation design of the new Web site, we in turn had to accommodate people who would access the site using a text browser in a hypertext environment which did not support images. Our primary concern was that none of the information

be lost as a result of the interface design which in turn affected how much emphasis could be placed on the visual aspects of the Web site.

It was indeed a compromise, as we soon discovered that designing hypermedia systems for access through the World Wide Web necessitated a trade-of between what the technology could be made to do, and whether people had a need for it. It also required a healthy dose of humility as we had to cast our designer egos aside in order to create a better communication environment for people, passing up the opportunity to shine in order to be useful. Although we could have easily added multimedia content to the new Web site, by doing so we would have been disregarding the needs of a large section of our intended audience.

6.6.6 evaluation

Once a working prototype of the new Web site was in place, the class presented it to the staff and students of the department of Art and Design and it was approved as the new departmental site. The implementation of the site was undertaken during the Summer of 1996 and it has been on-line (at http://www.ualberta.ca/~artdesin/) since September of that same year.

Despite careful design considerations and implementation, there have been unforeseen problems with this site. Some people were not able access the site because of either hardware or software constraints, which, in the most extreme cases, caused their computers to crash. After considering several alternatives, a preliminary warning page was added to the Web site which informed people of the minimal hardware and software requirements needed to view the site.

6.6.7 suggested changes

The content of the new Art and Design Web site needs to be rewritten since it was originally put together as a cut and paste exercise from the original Web site's information structure. In addition, there are plans to add graphics to both the staff and students sections to provide additional information to potential students, our primary target audience. Optimization is an issue that will have to be addressed in the near future as well, specifically regarding the management of the background graphics, the functioning of the graphical navigation maps and the colour palette. It appears that for the moment, however, we are taking advantage of hypermedia's forgiving nature to keep this Web site well under construction.

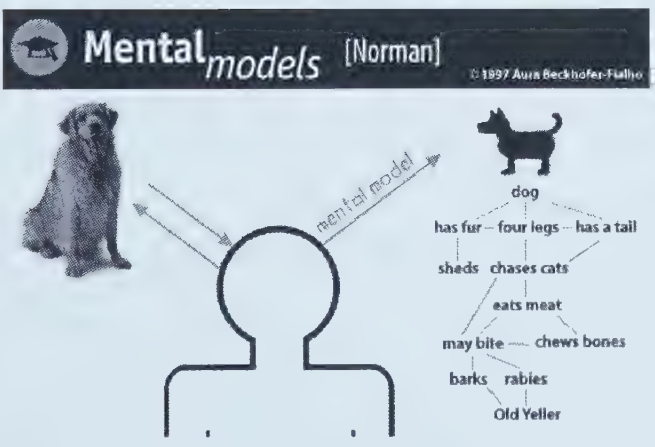
> **Does hypermedia have, or will it have, the ability to affect the learning process in a positive way? (Myers & Burton, 1994)**

As with any emerging technology, it is important to distinguish between theoretical promises and practical realities. This is particularly important since much of hypermedia nowadays is being used within an educational context, and often in an impulsive, rather than thoughtful manner.

The World Wide Web in particular has been recognized as a potentially powerful teaching aid, specifically when dealing with distance education. Primarily, the problems with such endeavours lie not in the concept of using hypermedia in an instructional environment, but rather in the inappropriate ways in which the content is commonly adapted to the new technology (and medium), and the role it is seen as playing in the educational process.

7.1 Norman's mental models

There are several cognitive and learning theories which can be applied in support of the use of hypermedia systems in a learning environment. Perhaps at the forefront is the concept of mental models put forth by D. A. Norman in the 1970's. Norman's theory is based on the belief that people form mental representations of their environment in order to "understand the subject matter or the object of their interaction; that is, to understand what they are learning." (Liu, 1994)



In essence, mental models retain the most characteristic features of an environment, a situation, an interaction. Thus, we not only form mental models of the things we interact with, but also of other people and ourselves. (Norman, 1983) This in turn allows us to predict and anticipate how certain situations unfold, based on our previous experiences, and enables us to deal with these in a semantically meaningful way.

7.1.1 research

Recent studies have shown that evoking mental models in hypermedia systems is a crucial factor in facilitating the navigation and understanding of information in such an environment. (Calvi, 1996) Further study has demonstrated that using a content map as a visual means to communicate a system's structure to a person is more conducive to generating a mental model of the hypermedia system than displaying a content list (Calvi, 1996), resulting in a better understanding and more efficient navigation through the content. What is interesting to note here is that studies have also been conducted in determining how a person's strategy (goal) determines their preference for either a content map or a topic list, regardless of the mental model evoked. (Dee-Lucas, 1996)

Essentially, it has been demonstrated through these studies that a person with factual learning goals preferred a topic list to select content from, whereas a person with information integration goals, thus with less specific needs, chose the content map to navigate through the system. (Dee-Lucas, 1996)

> **In the real world, when a system is constructed, the design will be based around a conceptual model. This conceptual model should govern the entire human interface within the system, so that the image of that system seen by the user is consistent, cohesive, and intelligible. (Norman, 1983)**

7.1.2 implications

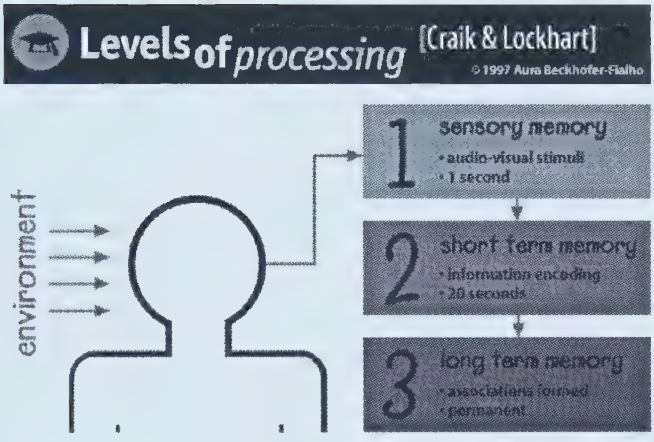
> **Learning is a reorganization of knowledge structures by constructing new nodes and interrelating them with existing nodes and with each other. (Norman, 1976)**

Indeed, the more links we can create between new experiences and previous ones, the easier the learning process becomes (Zhao et al, 1994), resulting in a more meaningful interaction and longer retention of information.

When designing educational hypermedia systems, we need to take people's mental models into account and in turn evoke a mental model of the system itself in order to make the interaction between the person and the information more meaningful. By attempting to create a mental model for the participant, we make the organization of the content explicit, in turn creating a system which is predictable and which becomes an intuitive and invisible channel for information exchange.

7.2 Craik & Lockhart's levels of processing

The theory of levels of processing draws upon the belief that we process various information from our environment at different levels. (Craik and Lockhart, 1972) The information which is in turn recalled is directly related to the initial depth of processing. Thus, the deeper the processing, the more semantically meaningful the information becomes, and the more durable it is as it gets transferred to long term memory. Shallow processing, on the other hand, results in easily-forgotten information, typically stored in short-term memory. (Bourne et al, 1986)



According to Craik and Lockhart's theory, the first level of information processing occurs at the sensory level, where we filter primarily audio-visual stimuli. This information is stored in sensory memory and is forgotten within one second if not processed at the next level. The next level of information processing involves pattern recognition where the initial sensory stimuli are converted (coded) to mainly phonemic and visual formats. (Bourne et al, 1986) At this level, information is stored in short term memory, which is considered an active form of memory where recently processed information is stored, along with recently recalled information drawn from long term memory. (Bourne et al, 1986) Retaining information at this level requires repetition (rehearsal) since short term memory is limited. If longer retention of information is to take place, the information processed in short term memory must be expounded upon and processed at a deeper level into our long term memory, where the information is mainly semantic, and stable. (Liu, 1994) Drawing upon these descriptions, we can surmise that the more familiar the stimulus, the deeper the level of processing, and thus the more meaningful the learning process. (Liu, 1994)

7.2.1 implications

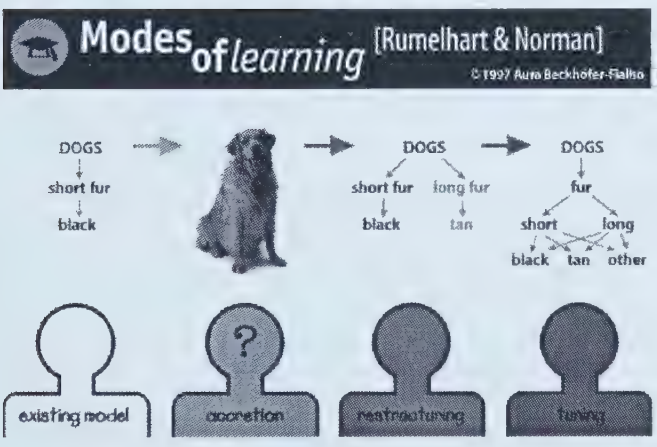
Craik and Lockhart's theory of the levels of processing state that in order for learning to take place, the organization of information must go beyond mere repetition and be semantically organized in order to facilitate a deeper level of processing which will result in longer retention of the information.

Based on Craik and Lockhart's theory, developing semantic-network-based hypermedia systems provides a meaningful learning environment by drawing upon the similarities in the realm of information processing between the human mind and the nodes and semantic links of a hypermedia system. This in turn enables the learner to process the information at a deeper cognitive level.

7.3 Rumelhart & Norman's modes of learning

> **Learning is connecting, and humans are good learners because they can make many connections. (Liu, 1994)**

Rumelhart and Norman's theory states that learning occurs in three basic modes: accretion, restructuring and tuning (Rumelhart & Norman, 1978). Accretion refers to an addition of new information to our existing body of knowledge. If this new information cannot be integrated within the existing knowledge structure, a new one emerges through a restructuring of knowledge which enables us to interpret the new information in a meaningful way. (Liu, 1994) According to Norman, "if accretion is knowledge acquisition, restructuring is knowledge understanding."(1978) Unlike restructuring, which involves creating a new knowledge framework to accommodate newly acquired information, tuning refers to the process of refining the existing structure in order to make it more accurate. (Liu, 1994)



7.3.1 implications

In order to learn more effectively, new information must be integrated into the existing knowledge structure, and old information should be reorganized to accommodate new information. Based on Rumelhart and Norman's theory of the modes of learning, hypermedia systems designed with a people-centred approach can become semantically-significant information environments which mimic the ways in which we organize information in our minds.

7.4 hypermedia-based instruction

Research into new information technologies often focuses on technological characteristics to promote – or deter from – the adoption of a new technology rather than on how people feel about using it and how in turn they understand it. Writing of hypermedia's features in terms of instructional value, Weller notes:

> **Unfortunately, there is very little research to date indicating whether all students are able to take advantage of such 'special' features. (1994)**

Individual differences in learning behaviour and cognitive style, for instance, are often overlooked in educational technology research, as are differences in levels of expertise in the technology itself:

> **Research into the extreme example of individual differences, the novice-expert dichotomy, has indicated that, in a variety of subject areas, differences in performance are often the result of differences in factual as well as procedural knowledge. (Shuell, 1986)**

It therefore appears obvious that in order to properly address how – and if – hypermedia should be used in an educational context, we should first address the issue of who will be using it, and for what purpose.

7.4.1 cognitive styles

> **Field dependence/independence, which has become one of the most commonly used measures of cognitive style, is a measure of how well a learner is able to restructure information based on the use of salient cues and field arrangement. (Weller et al, 1994)**

Field dependence/independence is an important issue to consider when addressing the implementation of educational hypermedia systems since it has a direct effect on who can benefit from them and who is less likely to do so. Various studies have demonstrated that field dependent learners are less inclined to impose a meaningful conceptual framework on an environment where no apparent structure is in place. (Weller et al, 1994)

In addition, field dependent learners experience difficulty in acquiring conceptual material where no guidance is provided. (Weller et al, 1994) This would lead us to conclude that whereas field independent learners may benefit from a self-paced interactive learning environment, field dependent

learners may in turn be at a loss as to how to extract meaning from a system which heavily relies on user control for information retrieval and processing. Thus, hypermedia may lend itself to a particular cognitive learning style, but may hinder another.

7.4.1.1 research

Research into the relationship between cognitive styles and learning performance using hypermedia-based instruction (HBI) was undertaken in 1994 by H. G. Weller, J. Repman and G. E. Rooze. The aim of the study was to determine whether cognitive style had an influence on how people navigated through the content of a hypermedia system, and whether it had an influence on how the information was in turn understood. The study involved 38 junior high school students in the United States. Prior to the experiment, the students were tested using the Group Embedded Figures Test (GEFT) to determine their cognitive style. (Weller et al, 1994) Based on their GEFT scores, they were then divided into three categories: field independent, indeterminate and field dependent. (Weller et al, 1994) The study required each student to learn about "computer ethics" using hypermedia-based instruction. A posttest was then administered to evaluate how much the students had learned about computer ethics and how much of that knowledge they could apply.

Overall, the results of the study showed that in hypermedia-based instruction, field independent students learned more effectively than field dependent students. (Weller et al, 1994) Furthermore, there appeared to be a high correlation between their GEFT scores and their posttest results:

> **The higher the scores of the field independent students on the GEFT test, the more information nodes they tended to access in the HBI [Hypermedia Based Instruction]. In contrast, the higher the GEFT scores of the field dependent students, the smaller the number of information nodes they tended to access. (Weller et al, 1994)**

7.4.1.2 implications

The research undertaken by Weller et al on cognitive styles and performance in hypermedia-based instruction underlines the fact that hypermedia is not necessarily desirable in all learning environments as its effectiveness appears to be linked with a person's cognitive learning style and cannot therefore be applied uniformly across an educational setting. This has a direct influence on how the World Wide Web, for example, can be considered as an alternative

learning environment for long distance education purposes. Perhaps an approach to integrating hypermedia technology in an educational context where it can benefit the majority of students involves building into it a flexibility which permits a more traditional – reactive – navigation through the content for field dependent learners, while also providing a pro-active access to information for field independent individuals. This goes back to the issue of user control which may at times be beneficial, but which should nevertheless be relinquished if the student prefers to play a more passive role in the decision-making process required in navigating a hypermedia system.

7.5 evaluating hypermedia

When a new information technology is developed and introduced to the public, there is usually an onslaught of research which emerges intent on proving the superiority of the "new" in comparison with the "old". Hypermedia is no exception. Nevertheless, according to Conklin, the problems of disorientation and cognitive overhead "may ultimately limit the usefulness of hypertext." (1987) In contrast, some researchers have stated that there is in fact a need for a certain amount of disorientation and mental effort in a hypermedia system in order to encourage exploration and learning. (Mayes et al, 1990)

When new information technologies such as hypermedia are implemented in an educational context, their effectiveness must be measured, especially if the new technology is introduced with the intention of displacing an older technology – print – rather than being used in addition to the existing environment. When evaluating hypermedia systems in an educational context, several researchers have suggested issues which should be addressed in order to develop an understanding of how people cognitively process information in hypermedia-based systems. (Balasubramanian, 1994) One such researcher, Jakob Nielsen, has identified at least three target areas of concern when evaluating the effectiveness and desirability of hypermedia-based instruction: utility, usability and integrity. (1991)

7.5.1 utility

> **The usefulness of hypertext[media] depends on its purpose, ease of navigation, and the population domain. (Balasubramanian, 1994)**

A popular approach to evaluating the effectiveness of hypermedia involves pinning it against a rival technology, namely print. Empirical studies often revolve around measuring whether hypermedia facilitates the execution of a predetermined task. This is in turn compared to a person's performance when working with more traditional printed material. (Balasubramanian, 1994)

7.5.1.1 research

A study on the utility of hypermedia as an alternative to traditional print-based instruction was conducted by Dennis Egan in which he tested information retrieval performance in two groups of students. One group used a textbook and the other used a hypermedia version of the same manual created with SuperBook™ software (Landauer, 1991). The data was obtained from a situation in which students were asked to find answers to specific, statistical questions. The results of this study were quite dramatic: the students using SuperBook™ scored "1.5 standard deviations higher" (Landauer, 1991) than those using the printed version of the same material. Egan then ran a control study in which he videotaped students using the textbook. This resulted in an important observation:

> **[Egan] discovered that they just as often found the relevant page as did the SuperBook users! Moreover they got to the relevant page just as quickly, and spent the same amount of time examining it. (Landauer, 1991)**

It would appear that the difference in performance lay not in the information being retrieved, but rather in the information being processed and understood in context:

> **The reformatting – rearrangement and highlighting – of the [electronic] page, or perhaps the search context in which it was found, caused one group of users to notice and absorb the information where the others passed it over. (Landauer, 1991)**

7.5.2 usability

The usability of a hypermedia system can be measured in terms of the ease with which a person learns to use it and how efficiently a person navigates through the information. This includes noting how many errors occur in the process in relation to a person's prior experience with the technology.

Usability also refers to the adaptability of a system to accommodate different strategies people employ when navigating through information: whether it

be browsing or finding specific facts which are relevant to a particular task. Evaluating the usability of hypermedia technology in a learning environment often involves, not unlike the utility research, a comparison setting where a new technology is contrasted with an established technology.

7.5.2.1 study 1

Research was conducted in 1993 by J. Psotka et al on evaluating the usability of a hypermedia system in learning the visual identification of aircrafts. Two experimental groups of five students each were established: one had access to the printed manual and the other had a hypermedia version of the same content. No reorganization of the material was undertaken in the latter, although search and comparison features were added to take advantage of the technology. The students were given a pretest to determine how many airplanes out of a pool of twenty they could name. They were then allowed 30 minutes to study twenty aircrafts. A posttest was later administered to rate their visual aircraft recognition skills.

The results of this study were significant: although students in both groups were able to learn the names of the majority of the airplanes, the hypermedia group rated higher in the posttest by identifying 17 aircrafts in comparison with 12.8 in the book group. (Psotka et al, 1993)

> **We showed that student novices could use hypertext[media] more easily than they could use a book to learn the names of airplanes, even though they were more familiar with the medium of the book. (Psotka et al, 1993)**

7.5.2.2 study 2

Following the initial study on evaluating the usability of a hypermedia system in learning the visual identification of aircrafts, J. Psotka et al conducted a second study into how different technologies affected specific tasks such as side-by-side comparison of visual data, and how in turn this affected learning and long-term retention of newly-acquired information. Fifteen students participated in this second experiment, in which they were separated into two groups: one using the printed manual, the other the hypermedia version.

Like the first study, the students were administered a pretest to rate their level of knowledge on the topic. The experiment involved learning the names of airplanes by pairing them up side-by-side in order to make the differences more noticable. In addition, a small cluster of 2 pairs of similar aicrafts were

presented to the students. A posttest was then given to the students in which they had to identify the airplanes which were presented side-by side. Finally, an additional "transfer" test was administered in which twenty new photographs not previously seen by the students were used to rate their depth of recognition in a novel situation.

The results of this second study yielded interesting results: the hypermedia group, once again, outperformed the book group. Furthermore, although both groups used side-by-side comparison almost equally, the hypermedia group visited each aircraft roughly twice as many times as the students in the book group. Making use of "rapid browsing" appears to have been a major factor in learning to identify the various airplanes as the students frequently went back and forth between images. (Psotka et al, 1993)

7.5.2.3 implications

The research conducted by Psotka et al on the usability of hypermedia in a learning environment demonstrates that in certain situations, hypermedia provides superior learning support, specifically in terms of rapid access to information, better retention of groups of four or more objects and a superior retention rate of information. (Psotka et al, 1993)

7.5.3 integrity

The concept of integrity relates to the structural aspect of the hypermedia system (Nielsen, 1991): its content organization, upgradability, and ease of maintenance. Since the information exists in a state of impermanence, it is important to design it in such a way as it becomes both usable and useful to the person who maintains and updates the system, as well as the learner.

Establishing a naming convention for all the components of the hypermedia system as well as maintaining extensive documentation are crucial in ensuring the integrity of the system over time.

7.5.4 concerns

Nielsen's guidelines for evaluating instructional hypermedia systems (based on utility, usability and integrity) although useful, are limited in scope. Perhaps their significance lies in providing a starting point for identifying criteria by which the value of a hypermedia system as a learning environment can be established.

An important factor which is often overlooked when evaluating hypermedia systems is the cost effectiveness of the technology itself. Wright (1991) identified the cost of production and dissemination as an important factor to take into consideration when evaluating the effectiveness of a hypermedia system in an educational context. The cost of production does not restrict itself to hardware and software requirements to access the system, but also refers to the human aspects of using hypermedia like disorientation, ambiguity and mental effort.

Inevitably, the obstacles which will stand in the way of a widespread use of hypermedia in an educational environment come down to practical, rather than theoretical issues: lack of (or insufficient) equipment, instructor education (and at times resistance) in using new information technologies, and the resulting curriculum adjustments which are necessary to a well-integrated information environment. More importantly, the evidence that hypermedia-based instruction does not lend itself to certain learning styles eventually limits the scope of its usefulness in an educational context.

Final thoughts

> **In the society of babble which we have, there is the imbecile, but there is also the mutant, [s]he who is capable of experiencing, in an interesting manner, the plurality of modern languages. (Eco, 1991, in Kessler)**

This thesis represents both an exploration and an outlet for ideas which have arisen from observing people's reactions to hypermedia systems which have either overwhelmed, enthralled or terrified them. The more I observed, the more I noticed that there was a need for people to understand what hypermedia was and how in turn they could use that knowledge to come to their own conclusion as to what this new technology means to them.

Designers in particular are finding themselves more and more frequently thrown into this new communication environment without having a formal education in the principles behind hypermedia technology and systems in general. We are called upon to make decisions on how to communicate successfully using a new technology, through a non-traditional medium, from which no precedent can be extracted. Thus, familiar metaphors are drawn upon to try and make sense of a new and unfamiliar situation which soon becomes stifled, uninteresting and often inappropriate.

My aim in writing this thesis was to bring the technology of hypermedia back to a human scale where it could be analysed and understood not in terms of promises, but in terms of how it can be used to design and develop useful information systems. By basing evaluation on theory and research rather than hype, I have attempted to shed light not only on hypermedia, but more importantly on how people can use this knowledge to evaluate the usefulness and relevance of a much hyped technology in a society where we often find it difficult to stop, step back, and think.

> **There is no final word. There can be no final version, last thought. There is always a new view, a new idea, a reinterpretation. (Nelson, 1990)**

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